POWER

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Homemade Power

If there is anything in signs, the power field is about to undergo a decided awakening in the possibilities of homemade power and its correlative services. Here are some of the high lights.

Smaller industries are, because of their greater mobility, getting under way more rapidly than the larger ones. Prosperity is being felt in this group since the amount of business offering is absorbed by the smaller concerns and as yet is insufficient to warrant full resumption of operations by larger ones. In other cases, the little fellows are successfully crossing competitive swords with big companies and have learned not to fear them.

Then again, the economic possibilities of industrial power plants are now receiving the attention of more engineers of wide experience, many of them previously too occupied with big jobs to pay much attention to this class of work.

The old bugaboo of endangered factory output from failure of the power services is being met by improved equipment and superior plant design, such as has never before been available. So the added expense of emergency connection with some outside power source is not the deciding factor it used to be.

The strength of the argument that industrial plants should stick to their own knitting and not bother themselves with the operation of power plants, with which they are not familiar, is being destroyed by the available supply of expert talent but recently come from some of the biggest and best power houses, fully prepared to take charge of new installations.

Place these thoughts beside the numerous others they suggest and you will see they are worthy of consideration from whatever viewpoint.

EDITORIALS

Taxing Electricity

The proposed federal tax bill has been placed before the House of Representatives by the Ways and Means Committee and its early passage is anticipated. Among its many ramifications is a two and one-quarter per cent sales tax applicable to all save a specified list of manufactured products, classed as necessities. It thus would apply to the sale of electricity, despite the unavailing argument that electricity should now be classed as a necessity.

While every effort has been made to collect the tax at the source and to prevent pyramiding, to the detriment of the ultimate consumer, there is hardly hope that the consumer will not, in the case of many products, actually pay the bill. In the case of electricity there may be some complications, especially where the interchange of energy between stations or successive resales are involved. There is also the question of whether accepted rate schedules under which customers are purchasing electricity will be held as inviolable contracts. If so, this, in effect, would be a manufacturers' tax and require utilities to bear the burden alone.

However it may be regarded, this tax will undoubtedly make it more difficult for the utilities to compete with privately generated power.

Add Voltage Studies To Power Surveys

Most plant engineers recognize the economic value of periodical power surveys of motor loads, as part of well-organized maintenance programs. Records of motor loads taken periodically provide information which, if properly used, will prevent large power losses, unexpected shutdowns and expensive repairs. These studies alone, however, may not tell the whole story.

Voltage readings particularly on alternating-current motors may be of equal importance to records of power loads. These motors are very sensitive to voltage changes, notwithstanding that they are designed to carry full load when their terminal voltage is ten per cent above or below normal. Knowledge that motors will operate under such conditions has caused a lack of appreciation of the economic value of maintaining rated voltage at the terminals.

Induction-motor torque varies as the square of the voltage. As a result, an induction motor driving a constant torque load, and operating on a voltage below normal will be reduced in speed while the load current materially increases. If the motor is operating at near rated power, the increased current may cause serious overheating of the windings. In any event the power losses in the motor, lines and generating equipment are increased. A certain amount of overvoltage may be an advantage if a motor is overloaded. Where power is purchased the reduction in power factor caused by overvoltage may increase the cost of current and this would be objectionable.

Overvoltage on synchronous motors increases the amount of excitation in the field coils necessary to maintain a given power factor, consequently reduces the efficiency of the motor. When power-factor correction is one of the motor's functions, overvoltage reduces its capacity for this purpose. No matter from what angle the problem may be considered, voltages much above or below normal increase operating cost and study may reveal possibilities of reducing the power cost not apparent from wattmeter readings.

Weldability Has Market Value

In the past a prime requisite of ordinary piping material was "threadability." If threads could not be cut with ease the piping was of little use for many purposes. With the development of Van Stone and similar joints for medium-pressure and high-pressure steam lines, came a demand for "flangability" in piping, so that pipe ends could be flared and flattened without splitting. Now arises the latest demand for "weldability," coincident with the increasing application of welding to the fabrication of piping systems for all services and at all pressures.

Most piping for use at low and medium pressures is already weldable, although some is better adapted than others to the production of sound joints by a variety of welding processes.

The case is different with the seamless alloy tubing so often selected by manufacturers, or specified by users, for extremely severe steam services, such as pressures up to 2,000 lb. and temperatures as high as 1,000 degrees. The composition of such tubing is often determined solely on its ability to withstand such conditions. But how about the joint? Lines of this sort have the greatest difficulty with flanged joints and are thus able to profit most by the use of welded joints. Yet, too often, the selected alloy can be welded only with great difficulty if at all. This is a fundamental oversight that will be corrected as the economic value of weldability gains recognition.

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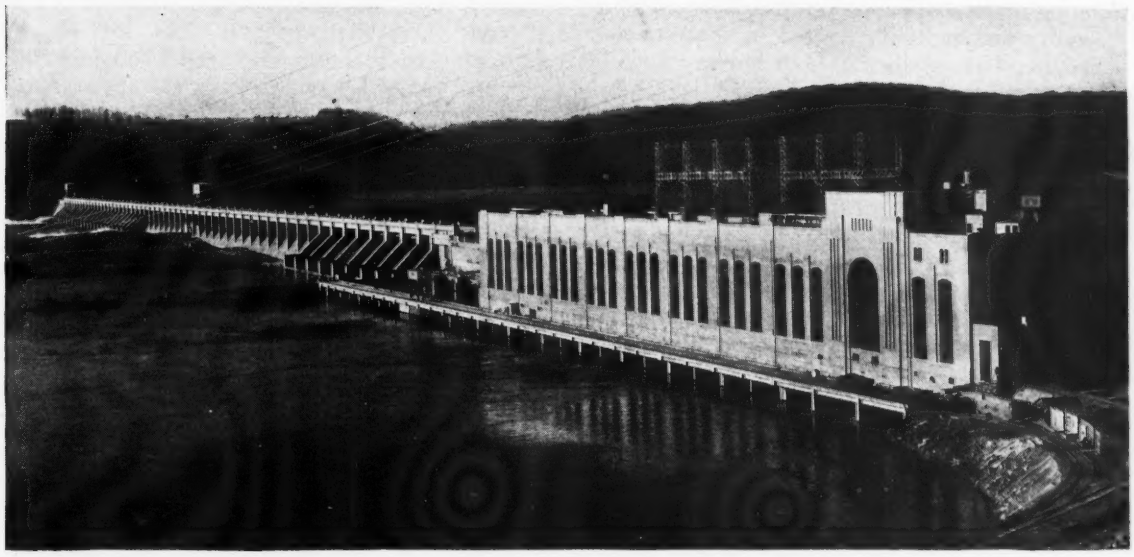
POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



Safe Harbor power house and dam comprise a structure 4,865 ft. long

Highest-Powered Kaplan Turbines Installed at Safe Harbor

Safe-Harbor hydro-electric plant of the Safe Harbor Water Power Corporation will have an initial installation of six 42,500-hp. automatically adjusted-blade propeller-type turbines to operate under a 55-ft. head. Provisions are made in the design for six additional units making the ultimate capacity 510,000 hp. These are the highest-powered units of their type in the world and have a discharge of approximately 9,000 sec.-ft. at full load

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FEW RIVERS in the United States have hydro-electric plants installed comparable with those on the Susquehanna in Pennsylvania and Maryland. On this river, between Columbia, Pa., and tidewater, there is a fall of about 225 ft. Practically all of this head is utilized in three great plants, which, when built to their ultimate capacity, will have an aggregate installation of over 1,250,000 horsepower.

Near tidewater, in Maryland, is Conowingo plant of the Susquehanna Power Co., with an installed capacity of seven 54,000-hp. units and space for four additional machines. This plant operates in parallel with the Philadelphia Electric Co.'s system. Fifteen miles above Conowingo is the Holtwood plant of the Pennsylvania Water & Power Co. It has been built to its ultimate capacity of 158,000 hp. and connects to the power systems of Baltimore, Md., and Lancaster, York and Coatesville, Pa.

At Safe Harbor, eight miles above Holtwood, the Safe Harbor Water Power Corporation, owned jointly by the Pennsylvania Water & Power Co., and the Consolidated Gas Electric Light and Power Company, Baltimore, Md. is rapidly completing a 255,000-hp. initial installation of what will be ultimately a 510,000-hp. development. This plant will eventually operate under a 55-ft. head, will back the water up to Columbia, and will connect to the same systems as the Holtwood plant.

All three plants are designed for run-of-river operation, and have sufficient storage to make them well adapted to peak-load service. They are normally operated on base load during high water, and carry the peak loads during low water.

At the site of the Safe-Harbor development there is an island in the center of the river. Beginning at the west side of the river there is a bulkhead section of the dam 482 ft. long. Between this and the island bulkhead is a 1,356-ft. spillway with 24 Stoney gates, each with a clear span 48 ft. long and providing for 32 ft. of water over their sill. Across the island a 1,356-ft. bulkhead section of the dam is constructed to which the east spillway section, 454 ft. long, connects. In this spillway there are four Stoney gates and four double-leaf gates, the latter for regulating flow. A 58-ft. bulkhead section connects the east spillway with the power house section 916 ft. long. Between the power house and the east bank of the river is a 243-ft. bulkhead The dam and powerhouse form a structure 4,865 ft. long.

With the exception that the upper leaf of each of the

four regulating gates, which are lowered by remotely controlled motor-driven hoists located in the tunnel inside the dam, the gates may be raised or lowered by either of two 150-ton gantry cranes. The upper leaf of the four regulating gates can be raised or lowered from the switchboard in the power house. This latter arrangement gives the switchboard operator control of regulating the pool level during normal flow, and serves as a fine adjustment when the larger gates are open. By this means the number of main-gate operations may be materially reduced.

A skimmer wall of structural-steel framing encased in concrete extends upstream from the west end of the power house, parallel with the river, for 1,400 ft. At its upper end the wall is connected to the shore by a rock-filled dyke forming a forebay for the plant. It is expected that this skimmer wall and dyke will keep the forebay free of floating ice and debris.

The power-house concrete substructure is built as part of the dam, and is designed for an initial installation of seven main units and two house-service units, forming a structure 610 ft. long. Intakes for five future units have been constructed in the dam, and provisions made so that draft tubes for them may be built at relatively low cost when additional capacity is required.

There are three intakes to each unit, which are protected by racks having bars spaced on 6-in. centers. The bars in these racks are stream-lined in cross-section so so that they offer a minimum resistance to the flow. A comparison of the costs of stream-line and rectangular bars showed that the former did not add materially to the investment for racks.

In the center intake of the three to each wheel is a gate with fixed rollers and a screw hoist. The other two intakes are equipped with plain slide gates that are lifted by one of the two gantry cranes on the intake deck. The filling of the penstocks and the final closing off of the water are done with the center gate operated by the screw hoist.

An outstanding feature of the plant is the propeller-type wheels with blades adjusted automatically as the load changes, to maintain high efficiency over a wide range of load. The relation between blade angle and gate opening can be varied manually to compensate for changes in head. When selecting the turbines four types of propeller runners were considered. These included the conventional fixed-blade type; manually adjusted-blade type, requiring shutting the unit down to make the adjustment; manually adjusted-blade type, adjustment being made while the unit is in operation; automatic adjustable-blade, Kaplan type, the pitch of the blade being controlled by the speed governor. Frances-type units were also considered, but because of their larger space requirements and loss of capacity under reduced head during flood conditions, they were not suited to existing conditions.

Propeller-type runners with manually adjusted blades with the units at rest were also considered unsuited to the expected load and head conditions. The difference in cost between units having manually adjusted blades when in operation, and those having automatically adjusted blades was not sufficient to warrant considering the former. This reduced the choice to either the fixed-blade type, automatically adjusted-blade type, or a combination of the two.

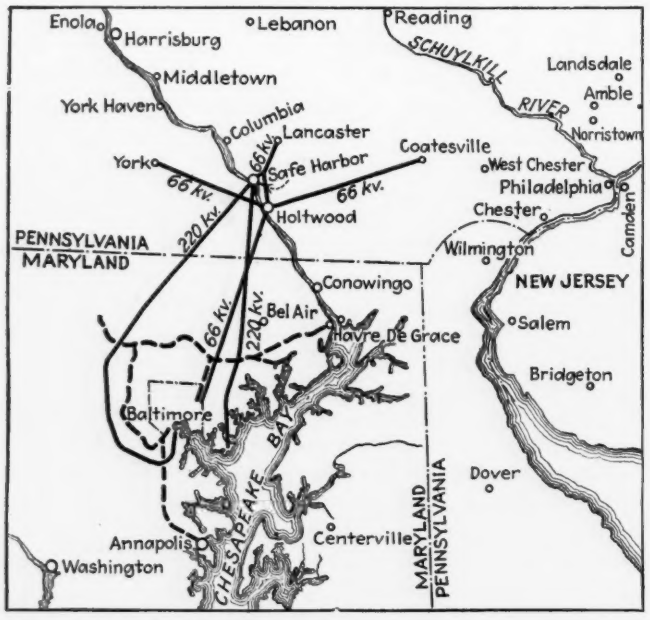


Fig. 1—Transmission lines connect Holtwood and Safe-Harbor plants with Baltimore, Md. and York, Lancaster and Coatesville, Pa.

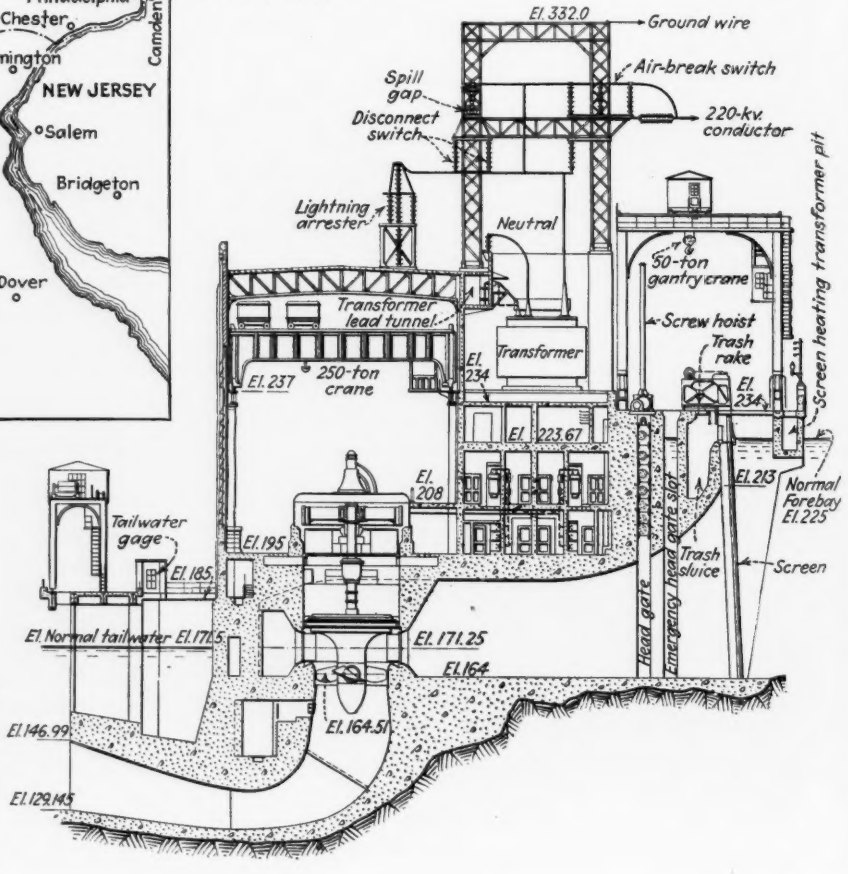


Fig. 2—The turbine runners are set with their center lines 7 ft. below normal tailwater level to prevent cavitation. This location was determined by tests on models in the hydraulic laboratory of the Pennsylvania Water & Power Company at Holtwood

It was found that the high sustained efficiency of adjustable-blade type units over wide ranges of load, and their higher output under reduced head during flood conditions, offset their 15 or 20 per cent higher cost over the fixed-blade type. A combination of automatically adjusted-blade and fixed-blade types would have met the conditions existing at the time the plant was designed, but it was evident that these conditions might not continue, and that it might be desirable to operate the plant in sections to meet future load requrements. These considerations, and the advantages of complete uniformity of design, led to selecting all Kaplan-type wheels.

The initial installation will include six 42,500-hp., 109.1-r.p.m. units. Four of these have been put into operation, and the other two will be installed during the next two years. Two house turbines of the francis type, rated at 3,100 hp. at 180 r.p.m., under a 55-hp. head, have also been installed. These Kaplan turbines are the highest powered in the world, have runners 18 ft. 4 in. in diameter, and will discharge about 9,000 sec.ft. at full gate and normal head. Their runners are set with their centerline 7 ft. below normal tailwater level, to prevent cavitation. This location of the runners with relation to tailwater elevation was determined by exhaustive model tests in the hydraulic laboratory of the Pennsylvania Water & Power Co. at the Holtwood plant.

Because the runners are below tailwater, special provision had to be made for unwatering the wheel casing. Two means of doing this have been made available. Two units are so equipped that the tailwater can be lowered automatically by admitting compressed air to the wheel's casing. As the gates on these units approach the no-load position the air valve can be made to begin to open and admit compressed air to the wheel casing. If the gates are closed, as during running-reserve or synchronous condenser operation, air pressure will be maintained automatically in the wheel casing that will keep the water level below the runner.

An alternative method of unwatering the wheels when there is work to be done is to put stop logs in the discharge end of the draft tube and pump out the water. Two movable unwatering pumps on special bedplates are provided. These are located in the unwatering tunnel and can be transported on an overhead monorail hoist to the unit where they are needed. The pumps can be anchored to slots in the concrete floor of the tunnel and connected to the draft tube by a special adapter fitting.

A great deal of study was given to the design of the governing system for the main units. On these machines the governor has to perform the double function of regulating speed and adjusting the pitch of the runner's blades. To provide for this the governor pressure tanks have about double the capacity of those for fixed-blade turbines. The units are arranged in pairs as related to the governing system. Each unit of a pair is provided with its own governor, oil pump, twin pressure tanks but with a sump tank comon to both units. The governor oil pumps, the actuators and the pressure tanks are on the operating-floor level. Below the operating floor is the sump tank, having two compartments. The two oil-pressure pumps, the four pressure tanks and the compartments of the sump tank are inter-connected so that either half or the system or both may be used. One pump and twin pressure tank has sufficient capacity to take care of two units. Normally, one pump will serve two units, but should it fail for any reason, the second

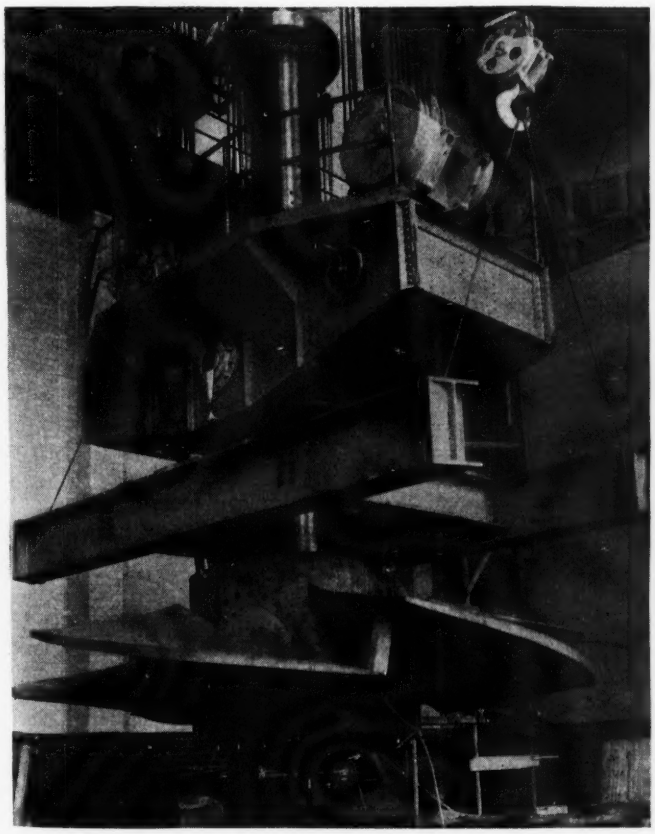


Fig. 3—One of the turbine runners supported in a special lifting equipment so that it can be handled by a crane

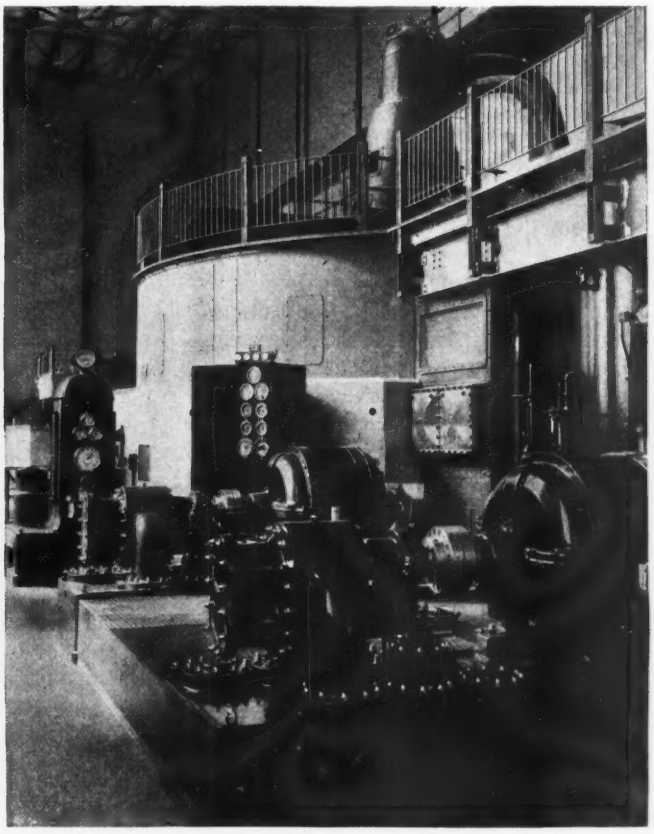


Fig. 4—The anchor bolts that hold the governor oil pumps to their base plate also connect them to the oil pipes

pump will be started automatically by a pressure switch. This arrangement is a combination of the unit and central governor oil-pressure systems.

A special feature of the oil-pressure pumps is the absence of external piping, Fig. 4, since the anchor bolts that hold the pumps to their base plates also connect them to the suction and discharge oil pipes. The pumping units were designed especially for quick replacement of either pump or motor, and they are located in the power house so that they may be served by the main power-house cranes.

Referring to Fig. 5, the governing system for a unit consists of the actuator *A* that serves the dual purpose of speed regulation and to adjust the pitch of the runners blades. The valves for the speed-governing mechanism are located at the actuator and the servomotors are on top of the turbine's crown plate, as is usual practice. For the blade-adjusting mechanism, the control valves are located on the operating floor at *B*, Fig. 5, and the servomotor is in the coupling at *C*, between the turbine and generator. The control valves and servomotor are connected by two concentric pipes, the inner of which can be displaced vertically to serve as a restoring rod, running down the center of the generator shaft. A shaft runs from the piston of the servomotor to the blade-adjusting mechanism in the hub of the runner. The runner's hub contains 1,100 gal. of oil, a sufficient head of oil being maintained to prevent water from leaking into the hub.

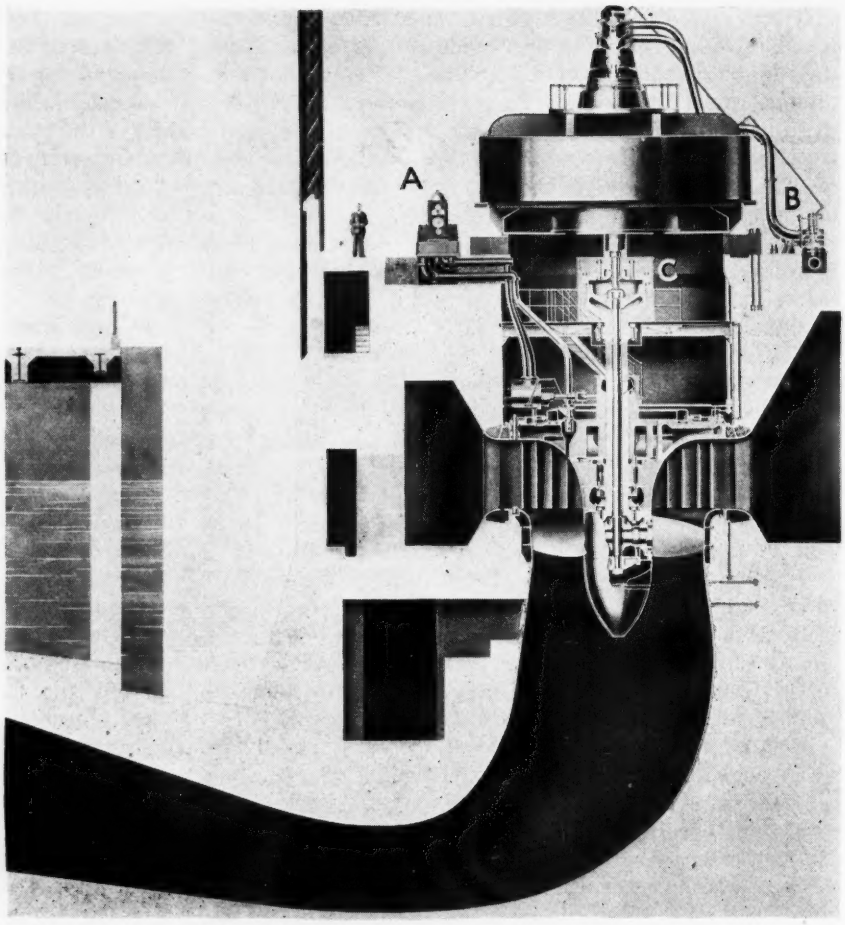


Fig. 5—The valves B and servomotor C adjust the angle of the runner blades to maintain high efficiency over a wide range of load

From the foregoing it is evident that the system for regulating the pitch of the turbine blades is similar to that for controlling the gates' position. The two work in synchronism, in response to the actuator on load changes. To compensate for the effects of change in head on the efficiency and power of the unit, the blade-adjusting valves are provided with a set of cams for altering the gate-blade relation. Normally, the units will operate under a fairly constant head, adjustment for changes in head being required at infrequent intervals only.

In the governor's operation and control of the machine there are some interesting features. Once a unit is started from rest the gates will not open above speed-no-load position until the actuator is energized by three-phase voltage. On the pilot exciter there are three slip rings to supply 162-volt, 7.27-cycle power to the actuator motor and the torque motor on the safety latch. Until the torque motor is energized with three-phase voltage, the pilot valve cannot rise beyond speed-no-load position, except when raised manually by a special knob which cannot be left in raised position. This is to prevent the unit from being placed in service under governor control without the flyballs turning. After the unit has started and three-phase voltage is on the actuator, failure of one phase will not shut the unit down, since the actuator motor will operate single phase and act as a phase converter to supply three-phase voltage to the torque motor to hold the safety latch in the released position.

The inherent speed drop can be adjusted to any desired relation between gate opening and speed by changing the position of a follower along a radial cam between the restoring mechanism and the speeder spring. Provision is also made so that if the relation between gate opening and power output should prove to be so distorted that at one part of the curve the power increases rapidly for a small change in gate opening, a special cam can be designed and substituted so that a straight-line relation between speed and gate movement can be obtained. This would prevent the unit from being oversensitive on one part of the governor stroke, and sluggish on another. The relation between machines when operating in parallel would then be stabilized, which is a highly desirable feature.

There is a definite load limit that can be applied to the machines without causing cavitation on the runners. Because of variations in head, due to flow changes in the river, the load limits will change on the machines. For example, as tailwater elevation increases, as during flood periods, the allowable gate opening may be increased without exceeding the cavitation limit. Provision is made so that equipment can be installed for setting of the load limit from the switchboard by the operator. The gate-position, load-limit position, tailwater and forebay levels are all indicated at the switchboard. The operator

will be provided with a set of curves showing the relation between load limit and cavitation for different head conditions, and it will be up to him to see that the machines are not loaded beyond the proper limit.

On the four units now installed, Nos. 3, 4, 5 and 6, the generators are three-phase, 60-cycle, 13,800-volt machines, normally rated at 28,000 kw., 0.9 power factor. Sufficient field and excitation capacity are provided to operate the generators at 31,111 kva. at 0.8 power factor and 60 deg. C. rise. The generators are designed mechanically for 36,000 kw. at unity power factor, and will have a maximum electrical rating of 36,000 kva. at 0.8 power factor and 80 deg. rise. These generators are of the overhung-rotor type with the Kingsbury thrust bearing and single segmental-shoe guide bearing combined in a housing below the rotor.

Generator No. 2, originally planned for three-phase, 60-cycle, will be built for single-phase 25-cycle operation. It will have a rating of 28,000 kw. at 0.8 power factor and 107.1 r.p.m. and will supply power to the Pennsylvania Railroad electrification between Perryville, Md. and Washington. A 300-r.p.m. outdoor frequency-changer set, rated at 25,000 kw., 0.8 power factor, will also be installed at the plant to convert three-phase, 60-cycle, power to 25-cycle single-phase for railroad load. The power house superstructure has been completed for seven units. No. 1 position is being reserved for a second single-phase 25-cycle unit, the speed-ring for which is now in place.

PRINCIPAL EQUIPMENT

Main turbines, 3	S. Morgan Smith Co.
Main turbines, 3	I. P. Morris Division—Baldwin-Southwark Corp.
House turbines, 2	S. Morgan Smith Co.
Governors	Woodward Governor Co.
Main generators, 4	General Electric Co.
Main generators, 2 House generators, 2	Westinghouse Elec. & Mfg. Co.
Thrust bearings	Kingsbury Machine Works
CO_2 fire-protection systems	Walter Kidde & Co.
Oil-treating equipment	De Laval Separator Co.
Storage batteries	Electric Storage Battery Co.
Main 250-kv. transformers	General Electric Co.
Main 66-kv. transformers	Westinghouse Elec. & Mfg. Co.
House transformers	American Brown Boveri (Allis-Chalmers Mfg. Co.)
13-kv. oil circuit breakers	Westinghouse Elec. & Mfg. Co.
13-kv. disconnecting switches and bus supports	Electric Power Equipment Corp.
480-volt air circuit-breaker switchboard (totally enclosed truck type)	I-T-E Circuit Breaker Co.
Main switchboard	Westinghouse Elec. & Mfg. Co.
Auxiliary switchboards	Westinghouse Elec. & Mfg. Co. Pringle Electrical Mfg. Co. Trumbull Electric Mfg. Co.
High tension (230-kv. and 69-kv.) disconnecting and air break switches	Railway & Ind. Eng. Co.
Flood gates and double-leaf gates	Newport News Shipbuilding and Drydock Co.
Double-leaf gate hoists	Bartlett-Hayward Co.
Head gates	M. H. Threadwell Co.
Head-gate hoists	Hardie-Tynes Co.
Spillway gantry cranes	Whiting Corp.
Intake gantry cranes	Morgan Engineering Co.
Power house cranes	Harnischfeger Corp.
Transformer crane	Morgan Engineering Co.
Draft-tube stop-log crane	Alliance Machine Co.
Heating boilers	Babcock & Wilcox Co.

Excitation for each main generator is supplied from a direct-connected main exciter and a pilot exciter. As already mentioned, the pilot exciter has three rings from which power is supplied to the flyball motor on the actuator. There is a motor-driven spare exciter that may be connected to any one of the main generators if the direct connected exciter fails.

Fig. 6—Four main units normally rated at 28,000 kw., 0.9 power factor are now installed with space in the present power house for three more

The construction work on the project was carried forward with unusual efficiency profiting by many favorable circumstances, and the plant went into operation several months ahead of schedule. Federal and State permits were obtained in April, 1930, to start cofferdam work in the river, and the first unit in the plant was started in December, 1931, one year and eight months after starting work in the river. Some idea of work involved is found in the fact that the construction included 1,700,000 cu.yd. of rock and earth excavation, mostly rock, and placing 490,000 cu.yd. of concrete in a structure nearly one mile long.

All the design work was handled by the engineers of the Pennsylvania Water & Power Co., as was the model testing of the unit in the laboratory at the Holtwood plant. All construction work was done by the Arundel Corporation of Baltimore while the installation of the electrical and mechanical equipment in the power house was handled by the power company's engineering and construction department.

1. Better Boilers
2. Modern Stokers
3. More Efficient Engines
4. Steam Waste Elimination

Cut Fuel Costs $12,000

In Long Island Institution

INSTALLATION of adequate equipment, seconded by a general tuning up of operation, presents an opportunity for many institutions to make drastic savings in their fuel bills.

Such a plant rehabilitation has reduced the coal bill of the Long Island College Hospital, Brooklyn, N. Y., $12,000 a year. The saving, based on a comparison between 1926 and 1931 figures, is additional to one of $23,000 made prior to 1926. In 1923 coal cost $49,670. The figure for 1926 was $26,393. In 1931 the bill dropped to $14,532. This second saving, with which this article is primarily concerned, was accomplished in the face of an increase of nearly 50 per cent in service demands.

Previous Savings Large

An article in the Oct. 26, 1926, number of *Power* explained the $23,000 saving made prior to 1926. Before that year hand-fired return-tubular boilers with careless firing conditions resulted in very low unit evaporations. Expensive anthracite coal was necessary. Bare steam piping, misuse of live steam, high steam rates of slide-valve engines, leaky pipe joints and badly packed valves resulted in great waste in the application of steam.

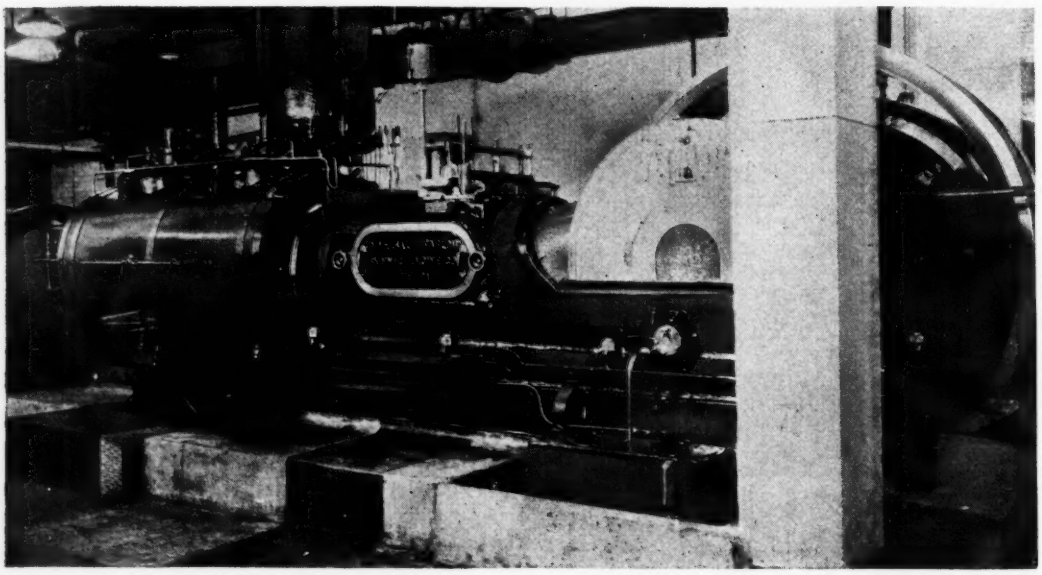
Then came a new management which made a survey of all hospital expenses, including those for power services. Need for drastic action was evident.

Semi-automatic stokers were installed to burn the much cheaper bituminous coal. Bare piping was insulated. Steam leaks were rectified. Wasteful steam applications in laundry and elsewhere were corrected.

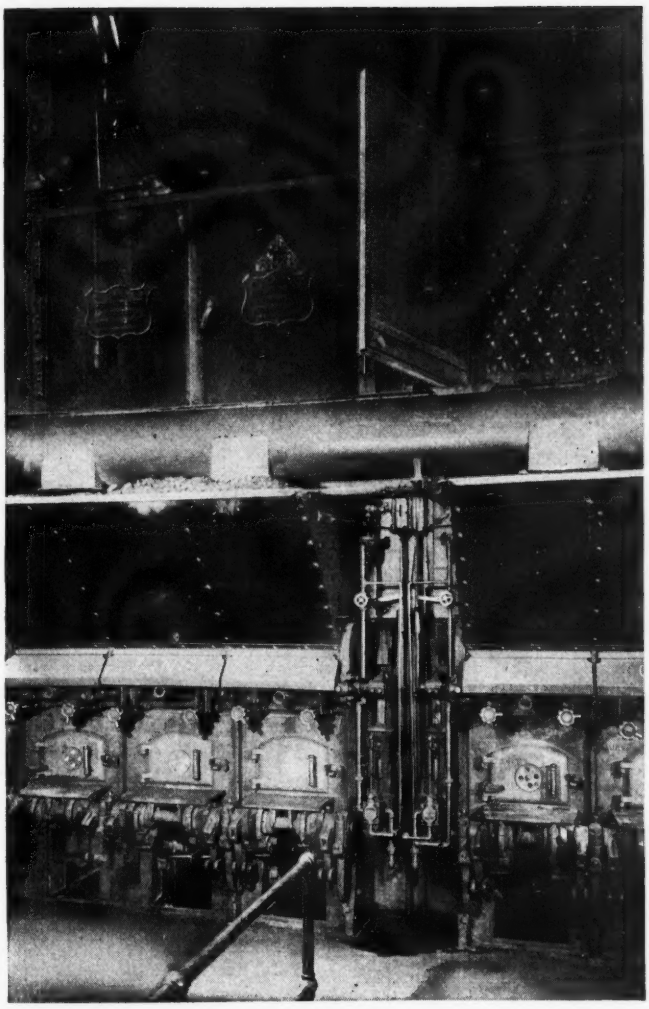
The net effect is evident in the coal costs for 1923 and 1926 in the following tabulation:

	1923	1926	1931
Tons consumed	6,800	4,223	4,265
Delivered cost per ton	$7.30	$6.25	$3.40
Total coal cost	$49,670	$26,393	$14,532

In spite of the notable savings, in 1926, there remained considerable room for improvement by further fundamental changes in equipment and operation. Specifically, the high steam rates of the slide-valve units wasted steam unduly in summer. Also, the inadequate boilers



Steam uses absorb entire exhaust of 150-kw. uniflow unit during nine months of year



Specially designed overfeed stokers use fuel mixture costing $3.18 per ton

left room for major betterment. Many possibilities remained for salvaging condensate still wasted to the sewer.

A vacuum pump was installed and return lines connected to all radiators throughout the plant, bringing back to the boilers all condensate at 180 deg. Thermostatic valves were installed on all tanks, and steam traps used whenever needed.

Opportunity to revamp boiler room and engine room was presented by the rapid growth of the institution. New buildings were added. Technical services were increased. As a result, steam and power demands required an immediate increase in capacity.

Purchased Power Studied

Comparative studies of purchased and generated power showed the desirability of new boilers and a modern engine.

To obtain needed room and to maintain continuous service a new boiler room was built. Additional service water heaters were installed in the old boiler room. The three new 2,575-sq.ft. water-tube boilers were equipped with overfeed mechanical stokers specially designed to burn a mixture of 40 per cent bituminous coal and 60 per cent anthracite dust. This equipment gave an average unit evaporation of 9.7 lb. of steam, with the coal mixture costing $3.40 per ton in 1931 and now obtainable for $3.18 per ton.

To achieve corresponding economies in steam consumption—and at the same time provide for the growing electrical load—a uniflow generating unit of 150 kw. capacity was installed in 1927. The entire exhaust of this unit is absorbed during nine months of the year and more than half during July, August and September. Thus the fuel cost of power is around 0.6c. per kilowatt-hour. Incidentally, repair costs on the uniflow unit have totaled less than $10 since its installation.

By these various improvements and others the yearly fuel bill has, as already pointed out, been cut nearly $12,000 since 1926. If account were taken of the increased load, the actual fuel saving would be much higher.

Further extension has been planned, particularly the installation of a 300-kw. uniflow generating set when the load warrants.

The improvements here described were carried out under the direction of Sheldon L. Butler, superintendent of the Long Island College Hospital, and Hartvik Carlsen, Chief Engineer.

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High-Temperature Installation At Delray Station

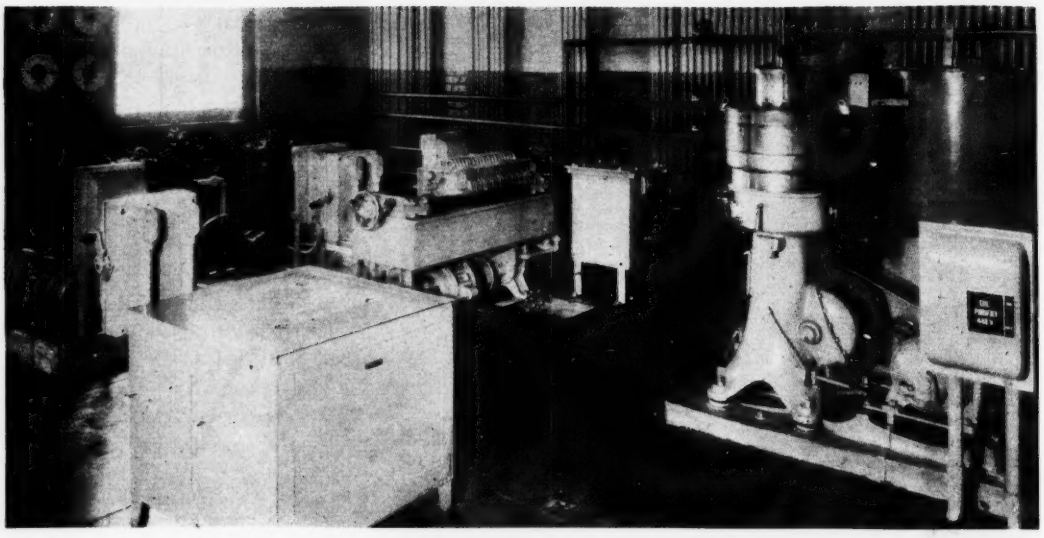
CONSIDERABLE has been published on the 1,000-deg. boiler and turbine at the Delray station of the Detroit Edison Company, but the current issue of the *Synchroscope,* published by that organization, contains an article by R. M. Van Duzer, Jr., giving additional information concerning operating experience with the unit. Mr. Van Duzer says in part:

"There has been no trouble with the operation of the turbine or superheater, and no deterioration of the various metals has been observed. The only troubles experienced so far have been the seizing of the throttle valve stem due to growth of the stem bushing, loss of some refractory tile in the superheater combustion chamber and a down draft in the superheater stack.

"The turbine has been taken out of service three times to repair the throttle valve since it has been in service using steam above 700 deg. The action of the high temperature steam on the valve stem liner caused this material to grow and seize the stem, thereby making the valve inoperative. A nitralloy stem and bushing have been installed in place of the original stainless steel stem and cast semi-steel bushing, and so far have given no evidence of trouble.

"Some idea of the effect of the steam temperature on the total steam requirement of the turbine can be gained from the steam flow-meter chart, which gives a record of station steam flow to the superheater. From 12:15 p.m. until 11 p.m. the load on the turbine was constant, while the temperature of the steam leaving the superheater was raised from 840 deg. to 1,005 deg. F. at 4 p.m., and then lowered to 860 deg. F. at 11 p.m. The steam consumption was reduced approximately 10.7 per cent by the 165-deg. increase in steam temperature, and was thereupon increased about 10 per cent by the 145-deg. decrease in steam temperature.

"The turbine, up to Jan. 30, has been in service for 3,113 hr., during which period it has been supplied with 1,000 deg. F. steam for 789.5 hours."



A modern insulating-oil purification plant equipped with a centrifugal purifier and a filter press

Proper Care of Insulating Oil Reduces Maintenance Costs

By MARIN PHILLIPS
Niagara Falls, N. Y.

The life and satisfactory operation of oil-immersed electrical equipment depends on the oil's condition. Where periodic inspection and testing of the oil are lacking, frequent breakdowns with attending high maintenance cost result. For this reason a schedule of routine maintenance and inspection of all insulating oils should be carefully followed on all oil-immersed equipment

▼

MOST FAILURES in oil-immersed equipment can be avoided if the insulating oil is maintained to standard specifications. The standard test for dielectric strength of insulating oil is to test it in an insulated cup having flat disk electrodes one inch in diameter and spaced one-tenth inch apart. The temperature of the oil under test should be between 68 and 86 deg. F. Fill the test receptacle to overflowing, pouring the oil in slowly to prevent air bubbles from forming. Where air bubbles do form they should be displaced, before applying voltage to the electrodes, by allowing the oil to settle for a while. A slight tapping on the receptacle with a pencil or similar stick will aid in ridding the oil of air bubbles. The test receptacle and electrodes should be carefully cleaned between each breakdown test. Insulating oil is considered as having excellent dielectric strength when it stands 30,000 volts without breaking down and is generally considered satisfactory when over 20,000 volts is required to cause breakdown. If the breakdown voltage is less than 20,000 the oil is rated as in poor condition.

By periodically inspecting and testing insulating oil one can judge by the oil sample when the equipment should be taken out of service for cleaning, overhauling and repairs. Following this routine will avoid possible explosion and fires in the equipment, and thereby shorten the time out for repairs as well as reducing the cost of maintenance.

The frequency of oil inspection and tests will depend on the type of equipment and its operating voltage. When the equipment operates at above 600 volts it should be considered high-voltage and given corresponding care. Where the insulating oil is cooled by water and there is a possibility of water getting into it as in oil-insulated water-cooled transformers, the oil should be tested for dielectric strength monthly, or oftener, if an unusual occurrence warrants it. By following this monthly test, moisture in the oil can in most cases be detected before a breakdown in the transformer occurs.

The accuracy of an oil test may be seriously affected if the samples are not properly taken and cared for until tested. The following points are important if correct test results are to be obtained:

1. Thoroughly clean and dry all containers used for handling oil samples. Place the containers in an oven to dry them thoroughly before filling with oil.

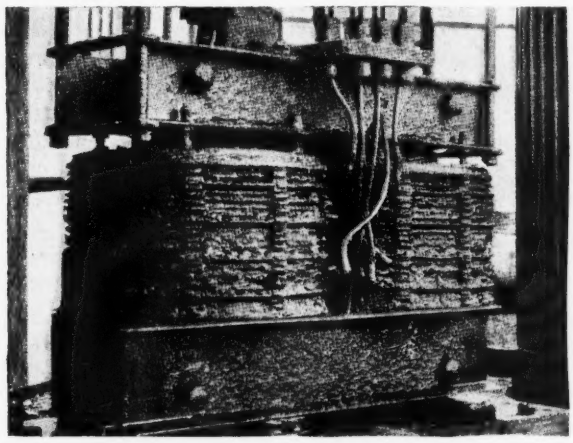


Fig. 1—Sludge on transformer coils causes increased temperature of the windings

2. Glass receptacles should be used so that the oil's condition as to water, sediment, sludge, etc., can be noted. They are also easier to clean and will not rust.

3. Rubber or composition rubber should never be used for containers, stoppers or gaskets.

4. Where oil samples are taken from the botton of the tank, let enough run to clear the valve of all settlings before taking the sample.

5. Make all tests as promptly as possible, after taking the sample, to prevent moisture collecting due to changes in temperature.

6. Tightly cork sample containers to exclude foreign matter.

7. The sample container should hold enough oil to make three tests and the average of the three taken as representing the condition of the oil.

8. Extreme caution must be exercised when cold oil is transferred to a warm location in order to prevent moisture getting into the oil due to the containers sweating.

As a further aid in keeping the dielectric strength of transformer oil high all gaskets should be kept tight. When it is necessary to disturb a gasket, such as when an insulator, hand-hole cover, or tank cover is removed, clean the surface well and paint it with shellac or bakelite varnish before replacing the gasket. In most cases a new gasket should be put on to replace the old one, which is likely to be damaged when removed.

When the dielectric strength on insulating oil begins to decrease it is an indication that either the oil is absorbing moisture or that it is being contaminated with sediment. To check for the cause of mosture go over all gaskets to see that they are tight. Next test the cooling coil to see if it is water tight. To do this disconnect the water piping from one end of the coil and connect a pressure gage in its place. Next disconnect the piping from the other end and connect a compressed air line that will supply about 75 lb. pressure with a valve near the tank. Fill the cooling coil with air and shut the valve tightly and disconnect the air line. Next spread a thick soap suds over the threads of all fittings. If there are any air leaks externally they will be revealed by a soap bubble forming where the air is escaping. If all connections are air tight note the pressure shown on the gage. Let the coils stand for 24 hr. under pressure and if they are airtight the pressure will remain practically constant.

When making this test there may be a change in pressure of one or two pounds without indicating a leaky coil. Should the air after standing in the coils, cool below the temperature that it was put in at, the pressure gage will show a reduction in pressure. On the other hand, if the air temperature increases the pressure will increase.

Another item that requires close attention if moisture is to be excluded from transformers, is the condition of the breathers. On some transformers the breathers are filled with calcium chloride, which must be changed at regular intervals, in order to keep them in effective operation. The principle of the breather is that the chemical absorbs the moisture that would otherwise be drawn into the transformer. The more moisture present the oftener it will be necessary to change the chemical. This type of breather should be watched closely and the calcium chloride changed when caking is noticed.

The next item in routine inspection of insulating oil is the temperature. Oil-insulated equipment should not be operated at a temperature rise in excess of that specified by the manufacturers on the nameplate of the apparatus. When this specified temperature is exceeded the cause

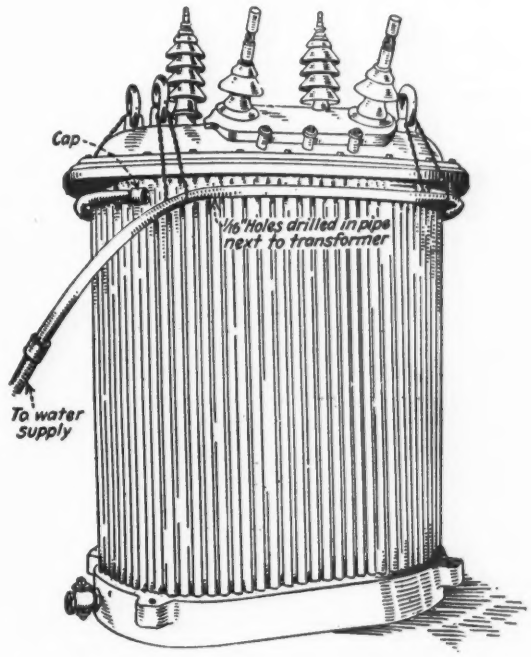


Fig. 2—Artificial cooling can be applied to a transformer by a water spray

should be immediately determined and removed as promptly as possible. It may be due to an overload, or the cooling medium may not be functioning properly. Artificial cooling can be applied by using fans or, in the case of a transformer, a water spray can be played on the outside of the tank. An effective shower can be made by drilling a series of small holes in a pipe and bending it to the circumference of the tank and making a water connection to it, as in Fig. 2. The shower is placed near the top and allowed to trickle down the side of the tank.

In the care of insulating oil, sludging, carbonizing and impurities must be watched and prevented from accumulating in the oil. Sludging is mostly caused by prolonged heating of the oil. The collection of sludge deposits can be materially lessened by avoiding excessive heating; by not exposing the oil to open air any more than is necessary; by not subjecting the oil to frequent excessive changes in temperature. Excessive sludging will cause the radiator and oil ducts to become clogged and cause uneven cooling of the windings. The oil should be filtered often enough to prevent this condition developing.

Sometimes sludging will be present even though the samples of oil test and look all right. The sludging may even be bad enough to affect proper cooling of the apparatus. For this reason it is advisable from time to time to have a chemical analysis made on the oil to determine its condition. Likewise, an inspection of the equipment's interior should be made to determine its condition in regard to sludging on the cooling oils, winding, core and other parts. Fig. 1 indicates the condition that a transformer may get into if not given proper attention. Where sludging is present it will be necessary to draw the oil off, lift out the winding and carefully clean all ducts and other places where sludging has accumulated. When filtering and transferring oil do not use a rubber hose as the oil dissolves the sulphur in the rubber and the sulphur attacks copper. It is effort well spent to filter transformer oil yearly, even if tests and inspection may show that this is not necessary.

Oil in Switches Carbonizes Rapidly

The insulating oil in compensators and oil switches carbonizes quite rapidly due to the heat of the arc when the circuit is broken. This disintegrates part of the contacts and the oil, resulting in finely divided particles of carbon and copper being present. Therefore, the oil in circuit breakers will also need a schedule of routine inspection. For reliable operation and low maintenance cost oil in compensators and oil switches should be kept as clean as possible. On some breakers this will require frequent cleaning and filtering.

When oil breakers are opened for inspection all carbon and copper dust should be carefully cleaned off the bushings, studs and contacts and the oil tank cleaned thoroughly. The oil should be strained through cheese cloth or felt, or filtered.

Badly carbonized oil may show a high dielectric strength when free of moisture. However, oil in this condition is more likely to break down from a slight absorption of moisture than oil free of carbonized particles. A great deal of this oil on low-voltage equipment can be filtered and reclaimed. But on high voltage equipment no chances should be taken by skimping on insulating oil. Where the old oil cannot be filtered and reclaimed for low-voltage work it is better and cheaper to discard it and use new oil.

Absorption of Air by Water In Pressure Tanks

By C. R. SESSIONS

THOSE who have had to do with a water-pressure system know that unless positive provision is made against it there will be a loss of air from the pressure tank, surge tank, or control device. When the air is nearly or all gone the tank is "water-logged." In this condition the cushioning effect of the air is gone and the automatic control responds violently to small pressure changes in the system. Of course this means unnatural wear and tear of the control and may put a serious strain on the tank, piping, etc.

One sure remedy for water-logging is to continually and automatically overcharge the tank with air and to provide an automatic means for releasing the surplus. A pump and its piping can be so arranged that air is drawn into the discharge pipe when the pump stops and this air forced into the tank when the pump starts again. For example, an air inlet valve may be put in the discharge pipe near a check valve and on the pump side of this valve and a small leak or drain made in the pipe further from the check valve so that when the pump stops water runs out of the small drain and air is drawn in through the air inlet valve. When the pump starts again this air is trapped and forced into the system, where it accumulates in the tank if the piping is properly arranged.

An air vent valve located on the tank at the low water level and in combination with a pressure relief valve provides automatic release of the surplus air. The air vent valve has in it a float which allows air to pass out but closes when water reaches the float. If the tank is overcharged with air the water level will be forced down by this air until the valve functions and releases some of the air. Sometimes only a valve like this is used, but if the automatic control were to be out of commission, all of the air in the tank would escape. This could happen if the power supply were cut off. Of course, when the power returned the system would again start to regain air, and by frequent starting and stopping, regain it quickly. But if a pressure relief valve were put on the outlet of the air vent valve the pressure would be lowered to a predetermined value and the useful air conserved.

Now it is interesting, if not necessary, to know how much or how fast air is absorbed by water being passed through a pressure tank. It is to be remembered that in some pressure systems all the water delivered by the pump does not pass through the tank, which may "float on the line" and be located on a branch.

Water entering the tank has with it the air absorbed at atmospheric pressure. When it leaves it has in it in addition an equal amount for each additional atmosphere or pressure of 14.7 lb. At 68 deg. F. and atmospheric pressure water will absorb an amount of air at 32 deg. and atmospheric pressure equal to 2 per cent of the water volume[1]. Thus if the gage pressure of the system is divided by 14.7 lb. and multiplied by 2 per cent, or if the gage pressure is divided by 7.33, the volume of free air absorbed, expressed as a percentage of the volume of the water going through the tank will be obtained.

[1]Marks Hand Book, page 313, Third Edition.

Gas engines, especially those in the oil fields, are installed almost invariably without any consideration as to the effect exhaust-pipe length and diameter will have on the engine performance, whereas by proper selection the engine's operation could be improved

Correct Exhaust Piping Improves Engine Performance

By H. F. SHEPHERD

THE PRESSURE in a two-stroke-cycle engine cylinder at any instant during scavenging very nearly equals that just outside the exhaust ports, since those passages usually are so large as to set up little resistance. The pressure at this receiving end of the exhaust system oscillates harmonically with an amplitude which compared to the scavenging pressure is great enough to exert a marked influence. If the exhaust pipe is a simple open tube these oscillations of pressure initiated by the forced movement set up by the discharge of gas when the ports first open recur with great regularity and with a frequency inversely proportional to the exhaust pipe length.

An exhaust pipe diagram, Fig. 4, was taken with a light indicator attached just below the cylinder to the exhaust connection of a 16 x 20-in. two-stroke-cycle gas engine. The diagrams in Figs. 1 to 3 were taken from the engine at the same time.

The first high wave, *ab*, Fig. 4, to the right indicates the entry of the slug of exhaust gas into the pipe. The cylinder contents continue to discharge into the pipe and the mass of gas starts flowing toward the exhaust outlet, with the result that the inertia of the gas causes the pressure to fall below atmospheric, drawing a vacuum at the cylinder end of the pipe, as indicated by point *c*. Air from the atmosphere rushes back to fill this void and raises the pressure to *d* before the piston reaches the end of its stroke. The column in the pipe rebounds again, drawing the pressure down to *e*. During this time the piston has reversed and started inward. Another surge raises the pressure to atmospheric at *f* and charges back into the cylinder under the pressure *g* as the exhaust ports are closing. After port closure the surges within the exhaust pipe continue until the next discharge.

The effects of the pulsations are good. The scavenging pump diagram, Fig. 3, taken from the scavenging air compressor, which is the crank end of the cylinder, shows a smooth and uniform discharge through the inlet

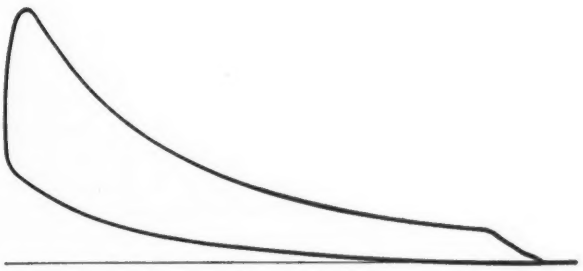


Fig.1 Power Cylinder

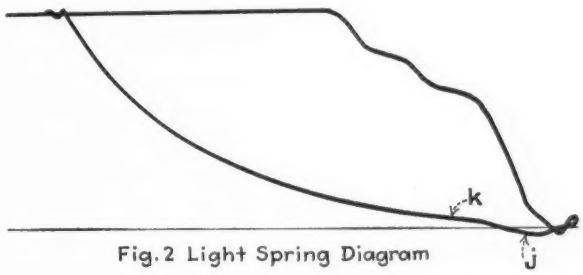


Fig.2 Light Spring Diagram

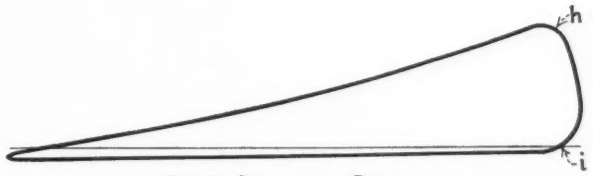


Fig.3 Scavenge Pump

Fig.4 Exhaust Pipe Diagram

Fig. 1 to 4—Diagrams showing result of a good pipe layout

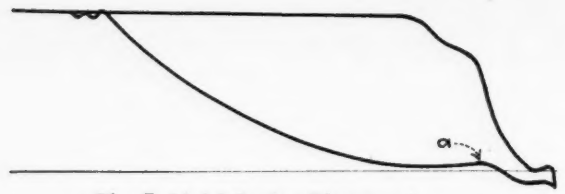


Fig. 5 Light Spring Diagram

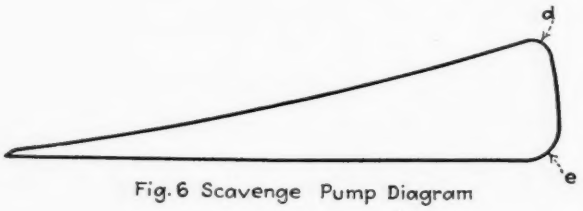


Fig. 6 Scavenge Pump Diagram

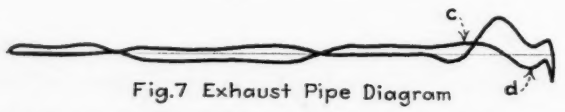


Fig. 7 Exhaust Pipe Diagram

Figs. 5 to 7—Diagrams obtained with a single pipe wave

ports along the line *hi*. Discharge is complete at *i* just before communication with the power cylinder is cut off by the piston. This is due to the vacuum at *e*, Fig. 4, which reduces the cylinder pressure and aids the transfer.

The light spring diagram, Fig. 2, was taken from the cylinder at the same time as the other diagrams. Having a scale of only 40 lb., a card 6 in. high would be required to show all events of the compression and power stroke, so a stop is used to limit the indicator's piston travel. This magnifies the toe of the diagram, showing clearly the beneficial action of the timed pressure waves. Charging of the power cylinder with the gas-air mixture finishes under a slight vacuum at *j* and a degree of final supercharging is shown by the convex line from *j* to *k*, at which latter point the exhaust ports are closed by the overriding piston.

At the finish of charging, the composition of the gas just outside of the exhaust ports is much like that within the cylinder, so the back surge adds to the cylinder

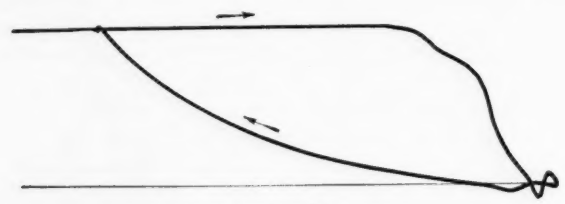


Fig 8 Light Spring Diagram

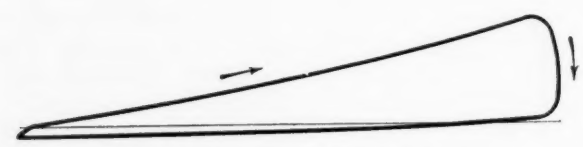


Fig 9 Scavenge Pump Diagram

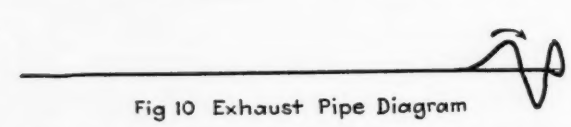


Fig 10 Exhaust Pipe Diagram

Figs. 8 to 10—Diagrams when the exhaust pipe was shortened

charge some fresh air or air-gas mixture that otherwise might have been lost out of the exhaust ports.

The power diagram, Fig. 1, taken under these conditions, is a very good one.

The pipe length of $12\frac{1}{2}$ ft. used when Figs. 1 to 4 were taken may not be possible where the engine is installed. Two complete harmonic waves *a b c d* and *d e a*, Fig. 4, were produced during the intervals of exhausting and charging under this condition. A single wave may be made to serve the same purpose as shown by the diagram, Figs. 5 to 7, which were taken from the same engine running at the same speed but with 25 ft. of exhaust pipe.

These are excellent diagrams, and attention is called to the supercharge *a*, at the toe of the light spring diagram. This is due to the return wave *c* in the exhaust pipe; as will be seen from the line *dc* in Fig. 6 on the scavenging pump diagrams a complete transfer of the scavenging air was obtained.

Diagrams from the same engine with a $6\frac{1}{4}$-ft. exhaust

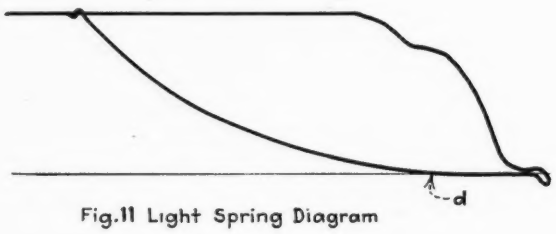


Fig. 11 Light Spring Diagram

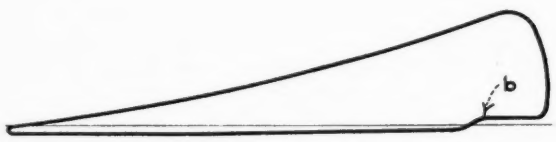


Fig. 12 Scavenge Pump Diagram

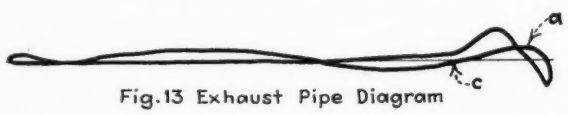


Fig. 13 Exhaust Pipe Diagram

Figs. 11 to 13—Inferior diagrams due to incorrect pipe length

pipe are shown in Figs. 8 to 10. This is just half the length of the pipe used when making the diagrams of Figs. 1 to 4 and one-quarter the length used to give the results shown in Figs. 5 to 7. The waves are damped out quickly, but it is clear that their timing is essentially correct.

Thus there are three favorable exhaust pipe lengths for an engine running at 200 r.p.m., namely, $6\frac{1}{4}$ ft., $12\frac{1}{2}$ ft. and 25 ft. By the same reasoning one may develop the fact that the three correct exhaust pipe lengths for an engine running at 400 r.p.m. are $3\frac{1}{8}$ ft., $6\frac{1}{4}$ ft. and $12\frac{1}{2}$ ft.

Effect of Unfavorable Exhaust Piping on Engine Operation

Thus far good results only have been shown. The diagrams in Figs. 11 to 13 illustrate what happens when an unfavorable pipe length is used. The exhaust pipe diagram, Fig. 13, shows back pressure at *a* during the final stage of charging. This is reflected by incomplete transfer at *b* on the scavenging pump diagram, Fig. 12. The exhaust pipe diagram shows a slight vacuum at *c*

when the exhaust ports are closing, which accounts for the failure of the compression line to get away from the atmospheric line until the point *d* in Fig. 11.

A case where the exhaust pipe was not only off the pitch, but too long, is illustrated by Figs. 14 to 17. Back pressure might have been expected in this case, because the pipe is 43 ft. long. This long gas column produced waves of very low frequency, as seen in the pipe diagram, Fig. 17. The vacuum phase line *ab*, not the back pressure, continues long after the exhaust ports are closed. Thus the cylinder pressure is less than atmosphere as the piston crosses the exhaust ports. The compression line in Fig. 14 leaves the atmospheric line at a point away from the end, indicating a volumetric efficiency for the power cylinder of only 71 per cent.

The harmful effects of introducing water into the exhaust may be seen from Figs. 18 to 20. These diagrams were taken under the same conditions as those of Fig. 1 to 4. The water in withdrawing heat from the gases, prolongs the vacuum from *a* to *b* in Fig. 20. The result is low volumetric efficiency of charging, as shown on the light spring diagram, Fig. 18. A good scavenging pump diagram is shown in Fig. 19, but this in itself means nothing. The air that is retained in the power cylinder produces the results and that drawn to the exhaust system by vacuum after the inlet ports are closed is a total loss to the engine.

Thus far only short straight exhaust pipes have been dealt with, useful only in the simpler oil field applications.

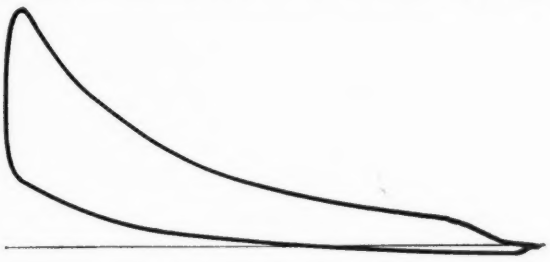


Fig. 14 Power Cylinder Diagram

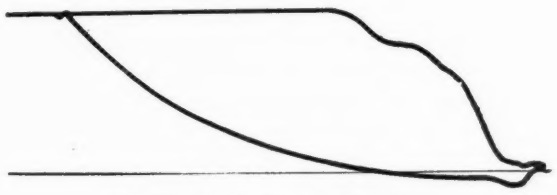


Fig. 15 Light Spring Diagram

Fig. 16 Scavenge Pump Diagram

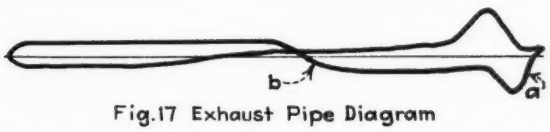


Fig. 17 Exhaust Pipe Diagram

Figs. 14 to 17—Results when the pipe was excessively long

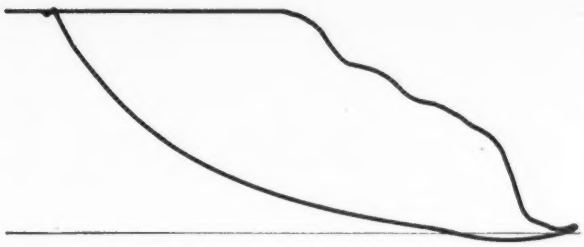


Fig. 18 Light Spring Diagram

Fig. 19 Scavenge Pump Diagram

Fig. 20 Exhaust Pump Diagram

Figs. 18 to 20—Diagrams with water injection

When the exhaust must be conveyed a great distance or when some degree of muffling is required, the continuation of the system should be so designed that it will have the least influence on the primary section already developed.

If it is required only to extend the length of the pipe the continuation should be enlarged to at least twice the normal pipe area. It cannot be made too large. The junction should be shouldered or tapered, as every effort should be made to prevent waves in the secondary section from being sustained and heterodyning on the useful waves in the primary section.

Better still, an expansion chamber may be installed between the primary and secondary lengths. The volume of this chamber cannot be made too large. The minimum, giving fair results in practise, is equal to 10 cylinder volumes provided the stack is short, one equal to 15 to 20 volumes is better.

Two exhaust lines from a twin engine may be joined into a single expansion chamber and stack, but individual systems are best though costly. The pipe diagram, Fig. 4, was taken from such a hook-up. Note at the left in Fig. 4 the wave *lm* is lower than the wave *ab* because it is reflected from one pipe while the other was being indicated. This wave can do no harm because the exhaust ports of the cylinder being indicated are closed. With some certain pipe length a successive wave set up by *lm* might meet *ab* and delay it but in the engine tested the wave *lm* died into vacuum *op* which is most favorable.

If it is desired to operate an engine at some other speed than 200 r.p.m. the correct exhaust pipe length will vary inversely as the speed, thus at 180 r.p.m. one should use $\frac{200}{180} \times 25 = 28$ ft. If the environment requires a specially long system it should be developed by use of the indicator.

From these tests the conclusion can be made that no gas engine should be installed without the exhaust pipe conditions being investigated, with a view to obtaining the most favorable length.

Selecting Elevators for an Office Building

By HOWARD B. COOK

Elevator service is an outstanding problem that confronts engineers both in the design and operation of buildings. This article shows how to determine the number of elevators for a given service and the treatment may be applied by either the designing or the operating engineer to checking the suitability of elevator to a given service. The problem has been greatly simplified by the use of curves

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TO DETERMINE the number of elevators required for all classes of service necessitates consideration of more than two hundred factors. When the problem is limited to a single class of service the number of elements involved is greatly reduced. The problem of providing adequate service in an office building divides naturally into two parts. The first is the number of passengers to be carried. It is customary to consider the five-minute morning peak of traffic as the controlling factor unless some peculiar conditions exist.

In a well-diversified office building the five-minute traffic peak will usually not exceed one-ninth of the building's population. When the tenancy is not so well diversified one-eighth of the population will be a more accurate estimate of the morning peak of traffic. In single-purpose buildings where all of the employees are required to report for duty at the same time, the peak may amount to one-third of the population. An installation calculated to care for normal requirements would be inadequate for such exceptional peaks of traffic.

Accurate, complete and comparable information regarding the flow of traffic in office buildings is very meager and building managers and superintendents would render a distinct service to others if they would obtain and publish data obtained from buildings over which they have supervision. Improvement in service will always result from a reduction of severe traffic peaks and these can often be reduced through intelligent supervision and cooperation from the tenants.

The morning traffic peak is used as the basis for calculating elevator requirements even though the evening peak is higher, because passengers congregating in the evening on the upper floors is not so objectionable as crowding at the first floor. Moreover, cars can be dispatched to individual floors in the evening and a greater number of passengers carried in a given period by this method. The population of a building will, of course, change with the rentable area per person and this varies from about 60 sq.ft. per person to about 150 sq.ft. per person, 100 being about the average.

The second part of the problem is to select, from many available combinations of elevators, the most suitable for carrying the estimated number of passengers. The number of passengers carried in five minutes by an elevator is equal to the number of passengers per trip multiplied by the number of trips made in that time. The number of cars required is found by dividing the number of passengers to be carried, by the number carried per car.

The round trip time of an elevator is equal to the sum of a number of variable factors, some of which are difficult to put in the form of an equation. It is possible, however, to determine values for the various factors and to add them together to give a value for the round-trip time that will be consistent with observed results with a fair degree of accuracy. Round-trip time can be divided into the traveling time and time consumed by other factors. It is customary to add ten per cent to the calculated round-trip time, when several elevators are operated in a bank, to cover time consumed because of the car being off schedule and other factors.

Traveling time depends upon the normal car speed, the average of the rates of acceleration and retardation, the distance between stops and the number of stops. The probable number of stops made by an elevator is less than the number of passengers taken on at the first floor. If the number of persons per floor is the same for all the floors at which stops may be made and if the car always stops at the top floor then the probable number of stops made on the up trip is found from the equation

$$\textit{Probable stops} = S - (S - 1) \times \left(\frac{S - 1}{S}\right)^{P}$$

where S equals the number of possible stops above the first floor and P equals the number of passengers taken on at the first floor. This equation was developed by S. G. Margles in 1922.

Fig. 1 gives the probable number of stops made by an elevator on the up trip. Three speeds have been selected, namely; 8, 10 and 12 ft. per sec. which are equivalent to 480, 600 and 720 ft. per minute.

It will be assumed that the average of the rates of

acceleration and retardation will be equal to 4, 5 and 6 ft. per sec. per sec. respectively. These rates are rather high and will be attained only with gearless equipment, variable-voltage control and automatic stops. The distances required for the attainment of full speed with start and stop are 16, 20 and 24 ft. respectively. (See "Rates of Starting and Stopping Elevators," *Power*, May 11, 1926.)

If the average distance between stops is less than the distance required to attain full speed, then the time per stop, in seconds, may be obtained by means of the equation $t = \sqrt{\frac{4S}{a}}$

where S is the average distance in feet between stops and a the rate of acceleration.

When the distance between stops is greater than that required to reach full speed and stop the car then the time per stop in seconds may be found by adding the distance required to attain full speed and to stop the car to the distance between stops and dividing the total by the normal speed in feet per second.

It is assumed that, during the morning peak of traffic, the car will descend from the top floor with the operator only and without making stops while descending.

Time-consuming factors other than traveling time are door operation, passengers entering at the first floor and leaving at the upper floors. The time required for door operation is an important factor in modern-elevator service. (See "Elevator Door Operation," *Power*, June 2, 1931, page 877.)

To show clearly the effect of this factor the round-trip time has been calculated for the three speeds selected with doors operating in 2, 3 and 4 sec. A door speed of 2 sec. for opening and closing is about the limit at the present time even with power-operated doors.

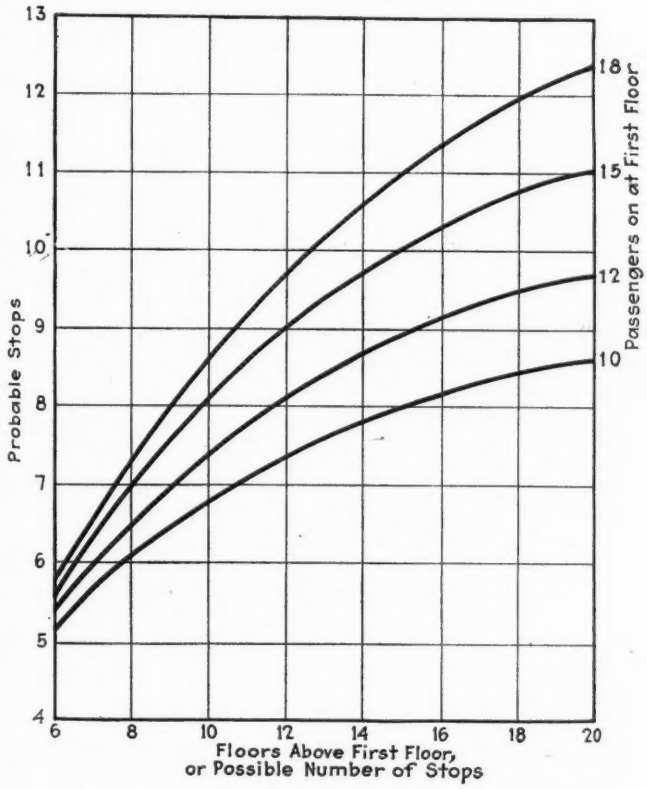

Fig. 1—Probable number of stops made by an elevator on the up trip

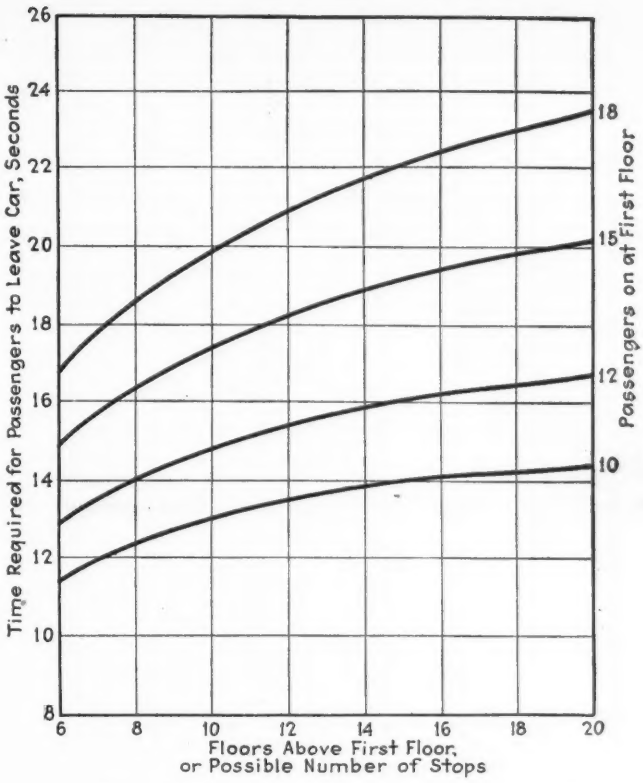

Fig. 2—Time required for passengers to leave the car

It is assumed that the time required for passengers entering the car at the first floor is one second per passenger. The time required for passengers to leave the car at the upper floors is influenced by the degree of crowding within the car and to reduce the effect of crowding, cars are not loaded to capacity during the morning peak of traffic. The effect of door width, rapidity of door operation and car shape upon the rate of passenger movement should be thoroughly investigated and the results published. The time required by passengers leaving the car at the upper floors is taken from curves of average observed results. Fig. 2.

Having established the values of the various factors affecting the round-trip time of an elevator it is not difficult to determine the round-trip time and the number of passengers carried in 5 min. by any equipment.

Curves showing the round-trip time and the number of passengers carried per car in 5 min. have been drawn for 10, 12, 15 and 18 passengers per trip corresponding to the number of passengers to be carried during the morning peak of traffic by cars having capacities of 2,000, 2,500, 3,000 and 3,500 lb. respectively, Fig. 3. These curves are calculated for a first floor height of 18 ft., other floors 11 ft.

It will be noted that the curves, Fig. 3, are not drawn to rectangular coordinates but the lines, indicating the number of floors, are inclined. This arrangement shortens the curves and spreads them farther apart thus making them more readable. The values for the points on the curves are calculated as follows:

The probable number of stops made by an elevator ascending with 18 passengers taken on at the first floor with 20 possible stops or 20 floors above the first is 12.4 as taken from Fig. 1. On this figure, take the possible number of stops, 20; run vertically to the 18-passenger curve and then horizontally to the probable

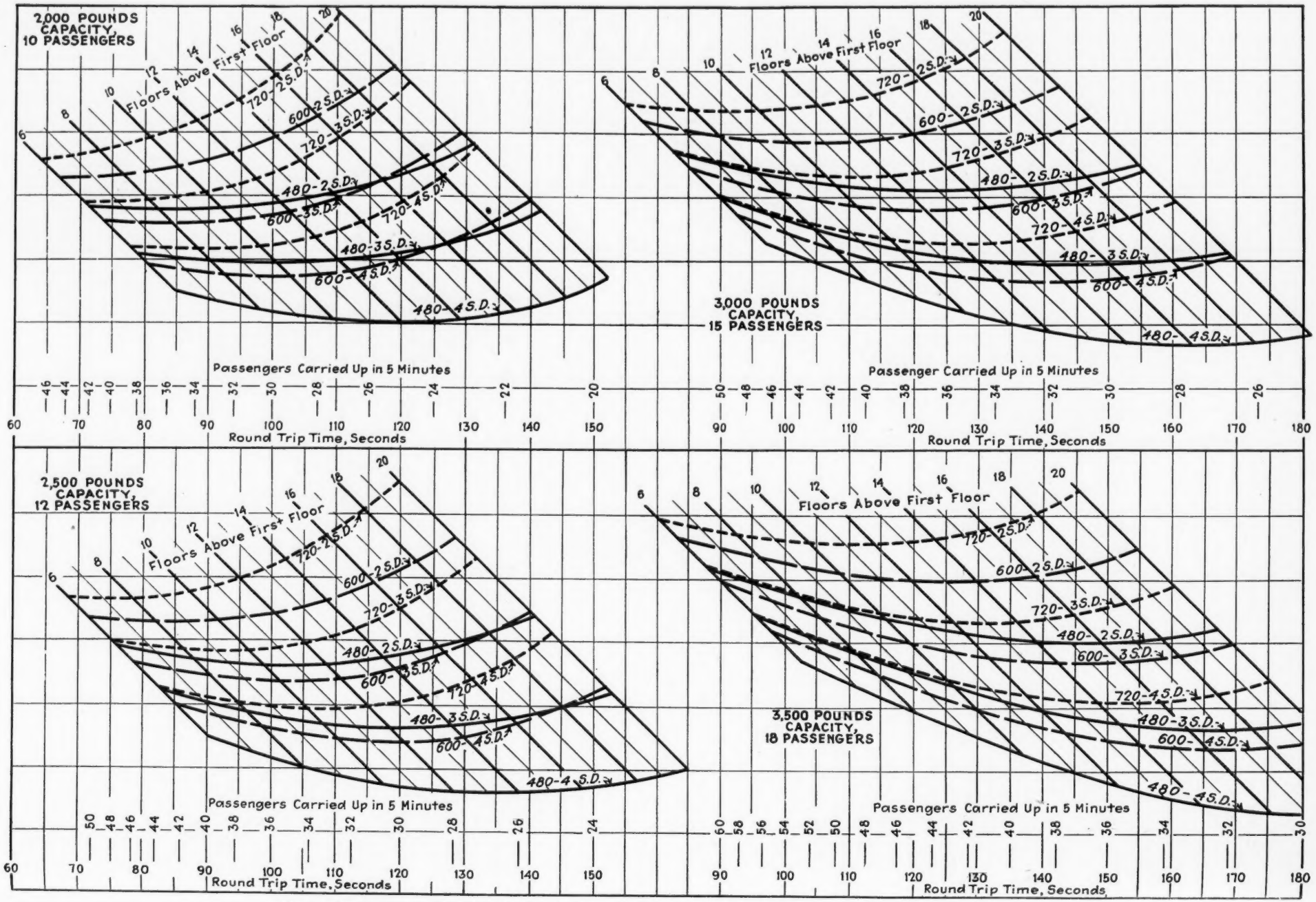

Fig. 3—Curves for determining the round-trip time and the number of passengers carried by an elevator

number of stops scale and the value 12.4 will be obtained. The time required to take 18 passengers on the car at the first floor allowing one second per passenger is 18 seconds.

The car rise is 19 floors plus the distance from the first to the second floors, or $(11 \times 19) + 18 = 227$ ft. Then the average distance between probable stops is $227 \div 12.4 = 18.3$ ft. At 720 ft. per min., the car is traveling 12 ft. per sec. To start from rest and accelerate to a speed of 12 ft. per sec. at a rate of 6 ft. per sec. per sec. will require $12 \div 6 = 2$ sec. The distance traveled during acceleration is $D = 0.5\ at^2 = 0.5 \times 6 \times 2 \times 2 = 12$ ft. A similar time and distance will be required to stop, so that accelerating the car to full speed and again stopping will require $2 + 2 = 4$ sec. and the distance in which this is done is $12 + 12 = 24$ feet.

This distance is greater than the average between stops, consequently, the car does not obtain full speed before it will begin to slow down to make the next stop. The average time per stop can then be found by formula $t = \sqrt{\frac{4S}{a}}$, and is $t = \sqrt{\frac{4 \times 18.3}{6}} = 3.49$ sec., so that the probable actual running time required by the car to make the up trip is $3.49 \times 12.4 = 43.3$ sec. The average number of doors to be operated on the up trip is equal to the number of stops plus one at the first floor, or a total of $12.4 + 1 = 13.4$. Allowing 3 sec. per door to open and close gives a total time of $13.4 \times 3 = 40.2$ sec. For the 18 passengers to leave the car at the floor stops requires 23.5 sec., as obtained from Fig. 2.

The time required to make the down trip without intermediate stops is equal to the starting and stopping time plus the time that the car runs at full speed of 720 ft. per min. The time required to accelerate to full speed and retard the car to rest has been found previously to be 4 sec. and the distance in which this is done is 24 ft. The distance traveled at 12 ft. per sec. is $227 - 24 = 203$ ft. and the time required to travel this distance is $203 \div 12 = 16.9$ sec. Then the time required to make the down trip without intermediate stops is $4 + 16.9 = 20.9$ seconds.

To make the round trip, the total time is equal to the time (18 sec.) required for the passengers to get on at the first floor; plus the running time (43.3 sec.) on the up trip; plus the time (40.2 sec.) required to open and close the doors; plus the time (23.5 sec.) taken by the passengers to get off the car at the different floors; plus the time taken (20.9 sec.) for the down trip; or $18 + 43.3 + 40.2 + 23.5 + 20.9 = 145.9$ sec. Adding ten per cent to this value as a safety factor give 160.5 sec. as the total round-trip time. This value will be found on the group of curves in the lower right-hand corner, Fig. 3, which is for a 3,500-lb., 18-passenger car, operating at 480, 600 or 720 feet per minute.

The identification marks on the curves, Fig. 3, such as 720—3 *S.D.*, 600—2 *S.D.*, etc., indicate a car speed of 720 ft. per min. with 3 sec. landing doors, and a 600-ft.-per-min. car with 2-sec. landing doors, respectively.

In the problem worked through there are 20 floors above the first, 18 passengers get on at the first floor, the car speed is 720 ft. per min. and the landing doors require 3 sec. to open and close. Applying these data to the curves in the lower right-hand corner, Fig. 3, find the diagonal line representing the floors above the first, follow this line until it intersects the car speed and landing door curve (720—3 *S.D.*) then drop vertically down to the round-trip time scale and the value 160.5 is obtained. A second scale is provided that gives the number of passengers that can be carried up in 5 min. On this scale 34 is obtained as the number of passengers carried up in 5 minutes.

As a further illustration of how to use the curves, Fig. 3, assume a 2,500-lb., 12-passenger car operating at 600 ft. per min. with 3-sec. landing doors, that serves 14 floors above the first. Find the floor line marked 14 and follow it until the 600—3 *S.D.* curve is intersected, then drop vertically down and the answer 118 sec. is found to be the time required for a round trip, when going up with 12 passengers in the car and coming down without stopping. The passengers carried in 5 min. is given as about 30.

Suppose that it has been determined that the morning peak of traffic in a 21-story building (20 floors above the first floor) all floors having the same population, would amount to 150 passengers in 5 min. This would be one-ninth of a population of 1,350 persons corresponding to a building of 135,000 sq.ft. of rentable area with a density of one person per 100 sq.ft., or 6,750 sq.ft. per floor.

The table shows the combinations available for serving this building as selected from the curves of Fig. 3.

VARIOUS ELEVATOR COMBINATIONS FOR SERVING A GIVEN BUILDING

Car and Door Speeds*	Number of Passengers per Trip	Round-Trip Time, Seconds	Passengers Per Elevator in 5 Min.	Number of Elevators	Interval Between Cars, Seconds	Class of Service
600—2 S.D.	10	119	25	6	20	Excellent
720—3 S.D.	10	121	25	6	20	Excellent
600—4 S.D.	10	140	21.4	7	20	Excellent
720—2 S.D.	12	120	30	5	24	Excellent
720—4 S.D.	12	144	25	6	24	Good
720—3 S.D.	15	150	30	5	30	Good
720—2 S.D.	18	144	37.5	4	36	Good
480—3 S.D.	18	180	30	5	36	Fair

*The first figures in this column are car speeds in feet per minute and the second figures give the time to open and close the landing doors. Thus 600-2 *S.D.* indicates 600 ft. per min. with 2-sec. landing doors.

Any of the combinations in the table would adequately serve this building but with varying degrees of excellence of service. (See *Power*, April 7, 1931.) When the number of available combinations has been narrowed down by the consideration of this factor then the final selection is made after considering first cost, operating cost, building space required and many other factors of varying importance.

It is important to consider that if the number of elevators to be installed is reduced to a minimum by the use of high-speed cars, automatic control and power-operated doors then any opportunity to improve the service or to care for additional traffic is practically eliminated.

To increase the speed of an installation above that for which it was designed is difficult and usually has very little influence on the service.

Express Service

The curves, Fig. 3, can be used for express service by the simple addition of the time required to travel up and down the increased distance from the first floor to the first local-floor stop.

An elevator having a speed of 720 ft. per min. and carrying 18 passengers per trip in a 21-story building would have a round trip time of 160 sec. with 3 sec. doors and would carry 34 passengers in 5 min. Eight

Fig. 3—Curves for determining the round-trip time and the number of passengers carried by an elevator

such elevators in local service would carry 272 passengers in 5 min. and the interval would be 20 sec. The service would be classed as good.

Now suppose that two groups of 4 cars each are substituted for the eight local cars and that one of the groups distributes passengers to the lower floors up to and including the twelfth floor or, eleven floors above the first floor. If 272 passengers are carried to 20 floors, then 150 passengers will be carried to 11 floors and each of the 4 cars must carry 37.5 passengers in 5 minutes.

Referring to Fig. 3 we find that cars carrying 15 passengers per trip at a speed of 600 ft. per min. and with 3-sec. doors will be suitable for the local service. The round-trip time is 117 sec. and the interval between cars, which is always equal to the round-trip time divided by the number of cars in the bank, will be $117 \div 4 = 29$ sec. The service will be classed as excellent.

The other group of 4 cars will be used for express service and if the first stop is at the thirteenth floor the express run would be 139 ft. and the time to be added to the values on the curves for 720 ft. per min. is found by subtracting 18 ft. (The time required to travel 18 ft. from the first to the second floors is included in the values taken from the curves) from 139 ft. which leaves 121 ft. This distance is multiplied by 2 for the up and down travel and the total divided by 12 (720 ft. per min. equals 12 ft. per sec.) and the result is $121 \times 2 \div 12 = 20.2$ sec. This value is increased by 10 per cent as a safety factor and the total amount to be added is $20.2 + 2 = 22.2$ seconds.

The number of passengers to be carried to the upper part of the building in 5 min. is 122, or $122 \div 4 = 30.5$ passengers per car. The round-trip time for 9 floors above the first with a 720 ft. per min. elevator carrying 12 passengers and with 3-sec. doors is 92 sec. and with 22.2 sec. additional for the express run the total round-trip time is 114.2 sec. The number of round trips in 5 min. is 2.62 and with 12 passengers per trip the number carried per car in 5 min. is 31. The interval between cars is $114.2 \div 4 = 29$ sec. and the service would be classed as excellent.

The arrangement of local and express cars reduces the cost of the installation and improves the service to the individual floors but the convenience to interfloor traffic is less. The improvement in service resulting from the express and local arrangement is due to the preselection of passengers at the first floor into two groups, which precludes a reduction in the number of stops, the number of door operations and the miles traveled. This arrangement also saves space in the building.

No Simple Rules for Selection

There are no simple and easy rules for the selection of elevator equipment for a building, but by a process of cut and try it is possible to select the most suitable arrangement. There is no occasion for wide differences in equipment for buildings comparable in size and requirements and it should be possible to select the elevator equipment for buildings of ordinary requirements without much difficulty.

Building owners, managers and engineers can do much to limit the peaks of traffic and improve the service if the installation has been properly planned.

The selection of elevator equipment for a new building is necessarily based upon an estimated volume of traffic but the actual conditions are always different and never remain constant. The number of persons per floor is never the same for all floors and transient traffic varies widely. The solution of problems continually arising requires constant attention on the part of those responsible for the operation of the elevators if the best service is to be attained at the lowest cost.

An accurate knowledge of the capabilities of the equipment is important. The elevators should be operated with a varying number of stops per trip without door operation to determine the traveling time. Another series of tests should be made including door operation but without passengers to determine the time required for door operations and the round-trip time with varying numbers of stops and passengers under actual operating conditions should be recorded.

An accurate count of the passengers should be made and recorded at 5-min. intervals. Passengers up and passengers down should be recorded separately. Interfloor traffic should be determined. Traffic counts should be made whenever conditions change sufficiently to influence the service.

It often becomes necessary to make extensive changes in an existing installation to improve the service. A very complete test and traffic count should precede such changes and the probable effect of each new factor should be calculated with great care before a final decision is made. In making the calculations the foregoing analysis and curves will be found helpful.

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Small Turbines Also Need Periodic Inspections

IT is just as important that the small, auxiliary turbine be inspected internally at regular intervals as it is that the large, main power unit be given this necessary attention. A recent accident to a turbine driving a condenser circulating pump brought this forcibly to attention.

The plant where the accident occurred made a practice of having its main units inspected regularly and kept in the best possible condition. When it was found at one inspection that sediment had not only collected on the buckets but had also fouled the quick-closing valves on two of the units so they could not operate properly, the management immediately had the sediment scraped out and took steps to correct the condition of the steam. However, the probability that sediment had collected also on the buckets of the auxiliary turbine was overlooked, with the result that the overload on the thrust bearing, together with poor oil, finally resulted in so much wear that the rotor moved lengthwise and damaged the buckets. A whole new wheel was necessary.

Auxiliary turbines frequently receive a poorer quality of steam because of their usual location below the main units and at the bottom end of the steam piping. In addition, there is a strong temptation for operators to give less care and attention to the proper lubrication and other operating details of these machines when they are more or less hidden away in the basement or boiler room. As a result, failures of buckets, speed control mechanisms, bearings and thrust bearings are more likely to occur and to result in serious damage than in the case of large units that are being given constant attention.

—*The Locomotive*, January, 1932.

PRACTICAL AIDS

TO OPERATION

Improved Anemometer for Low Velocities

THE ANEMOMETER illustrated was built at a cost of less than one dollar. It has served satisfactorily for measuring low velocities in ventilating work.

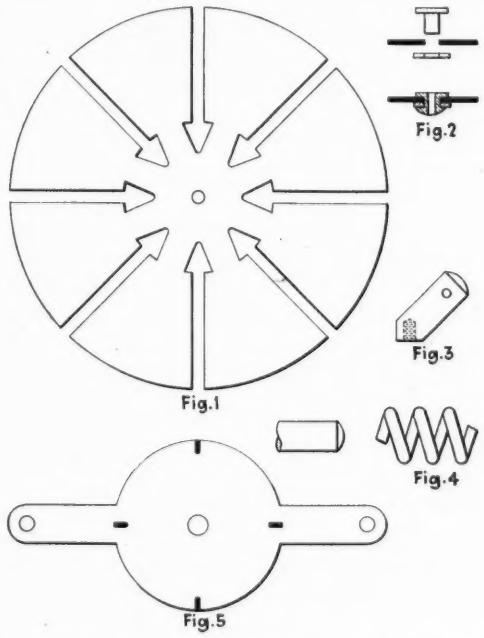
The vane is one-piece aluminum, with a hub built up of a copper rivet and burr. The vane was cut to an approximate diameter, $4\frac{1}{4}$ in. in this case; then the hub was attached and drilled for the supporting shaft. With this hole as a center the final diameter of the vane, $4\frac{1}{8}$ in., was marked upon the sheet aluminum. This assured a central location of the axis of rotation. Eight vanes were cut as shown, and bent so that their angle of inclination was about 45 degrees.

The shaft supporting the vane was No. 16 piano wire. The worm on the end of the shaft was made by winding a copper helix, lightly coating the piano wire with solder and "sweating" the worm on. The shaft was also sweated to the copper hub. Fig. 4 shows an enlarged view of the worm and shaft before assembly.

The bearings for the vane shaft were formed by drilling two number 8-32 brass machine screws axially. Two bars shown spanning the ring were tapped for these screws. The supporting ring, or shell, was of cast iron, $4\frac{1}{4}$ in. inside diameter and about $1\frac{1}{4}$ in. wide.

The dial was cut from galvanized iron, lacquered white, with black quarter marks, as shown.

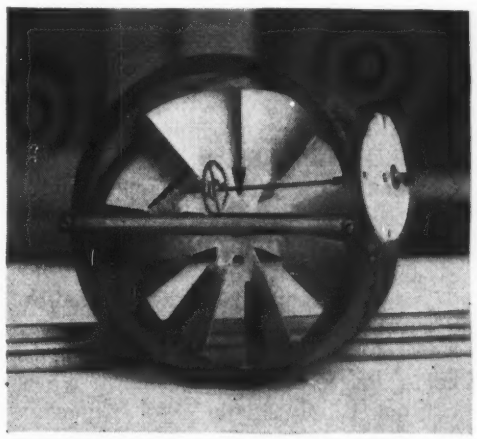
The worm gear on the vane shaft meshed with a small clock gear. This gear was sweated to a shaft of No. 16 piano wire, and soldered to the end of the shaft was the pointer which moved over the dial. One bearing of the shaft was formed by drilling a bracket as shown in Fig. 3. This bracket was attached to one of the brass bars spanning the supporting shell, or ring. The other bearing was formed by the shell. A small collar prevented end play.



Detail of vane before shaping blades and other parts

The device, after being completed, was "run in" for several hours by placing it in an open window where air currents would operate it.

Calibration of the anemometer was accomplished by clamping it to an arm which rotated in a horizontal plane. The arm revolved at a rather low speed, and the calibration was carried out in a closed room. The number of revolutions made by the pointer was determined for various settings of the anemometer along the arm and these readings were made up into a curve as follows: Suppose that the arm is revolving at 30 r.p.m. and the anemometer is one foot from the center of rotation. The length of the path it traverses in one revolution is $2\pi \times 1$, or about 6.28 ft. If this path is traveled thirty times per minute, 30 r.p.m., then the anemometer will have passed over a linear distance of 30×6.28 or 188 ft. At the same time the number of times the pointer has moved over the dial has been counted, so that one value can be plotted against the other.



View of anemometer showing pointer drive

Few dimensions have been given, as the size of the parts will vary with the material at hand. It is hoped that others who may have temporary need of a device of this kind will find these suggestions an aid in its construction.

ARTHUR M. HILL.

New Orleans, La.

Protecting Vapor-Flow Indicator On Dry Vacuum Pump

In many installations of condensing steam turbines equipped with rotary dry vacuum pumps, these pumps are connected with a vapor-flow indicator on their discharge side. When starting up the turbine the vacuum pump is usually placed in service a short time before steam is admitted to the turbine in order to remove air from the exhaust system and pull a partial vacuum. When starting in this manner the pump is usually handling a much greater volume of air than it ever would under normal operating conditions and as a result the flow indicator will be far off its scale.

In order to prevent damage to this instrument a nipple and globe valve, of about one-quarter the diameter of the R.D.V. pump discharge, should be installed between the pump and the indicator. This valve should discharge to the sump at atmospheric pressure and should always be opened when starting the pump until the vacuum in the suction system has risen enough to show that the indicator reading would not be off the scale.

West Roxbury, Mass. H. M. SMITH.

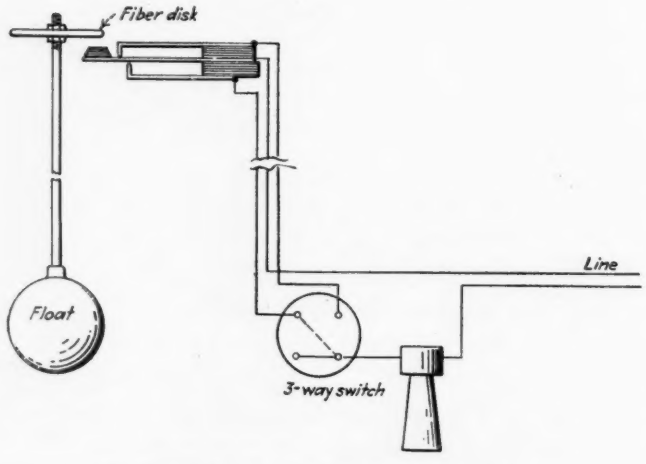
Alarm System for Float Switch

WE HAVE a reserve oil tank for bearing oil supply which floats in on the pump line and in case the pump stops the reserve tank keeps the oil flowing while the engineer is restarting the pump. The tank has capacity to supply oil to the bearings for over an hour if necessary.

This float switch was made on the job, and is set to blow the horn as soon as the oil level in the tank drops about 4 in. The fiber disk presses down on the extended switch arm, which interrupts the upper contact circuit and closes the bottom circuit, blowing the horn until the three-way switch is operated to stop it and automatically cutting in the upper contacts. When the tank is nearly full the upper contacts will reclose and blow the horn again, warning the engineer that the tank is full and the three-way switch must again be operated to stop the horn and put the circuit in operating condition for the next pump failure.

The main advantage in this arrangement is that it is impossible to forget to reset the alarm when the tank is full again. If only a single-pole switch were used this would be likely to happen occasionally and possibly ruin a set of bearings.

The shaded portions of the switch indicate insulation. We used half-inch thick bakelite, but hard fiber



Arrangement of float switch and connections

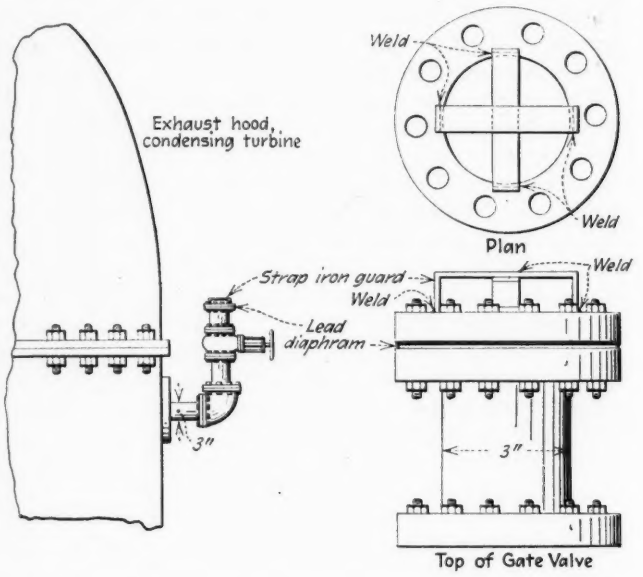
would be satisfactory. The contact strips are $\frac{1}{4}$ in. wide x 1/16 in. thick spring brass and are mounted on the bakelite with small brass machine screws (not shown) long enough to serve as a binding post for the connection. The extension of the middle strip has an insulated contact surface secured to the metal with machine screws tapped into the material, however, it is not necessary to use an insulated disk on the float rod.

Nashville, Tenn. T. E. MILLER.

Preventing High Exhaust Pressure In Turbine Casing

PROVISION to prevent excessive pressure building up in the exhaust hood of a condensing turbine must be provided in each installation. On many large installations a low-vacuum trip is provided. In the case of a machine rated at 28 or 29 in. vacuum this trip will operate when the vacuum drops below its setting, usually 10 to 20 in. hg. This trip is generally connected to the emergency turbine governor through a pilot valve.

While a vacuum trip is satisfactory and often em-



Detail of lead diaphragm relief arrangement on turbine housing

ployed, it should be supplemented with some other safety equipment in many cases.

In one installation a heavy lead diaphragm was placed between the flange at the top of the exhaust hood and a companion steel ring on the top. In event of the trip's failing to operate the governor this diaphragm would blow out and at once place the condenser pressure at atmospheric. When this occurred it was a several hours' job to replace the diaphragm and get the turbine back into service.

To lessen the possibility of this diaphragm's rupturing a 3 in. line was tapped into the manhole at the side of the exhaust hood. A gate valve was placed in this line. At the top of a short nipple a flange, lead diaphragm and steel ring was placed similar to the one at the top of the turbine. The lead in this small diaphragm was of much lighter gage than that in the larger one on the turbine, and it could be depended upon to blow out first in case of such trouble. By this indication and pressure relief the operator could trip the turbine by hand if it was still on the line and further relieve the pressure by other auxiliary valves to prevent the blowing out of the large diaphragm. As soon as the cause of the vacuum loss was correctd the small gate valve could be closed and the turbine started at once, the small diaphragm being replaced when convenient. A strap iron guard was placed over the diaphragm as shown.

HARRY M. SPRING.

Boston, Mass.

CURRENT COMMENT

Diesel Cooling-Water Systems

IN THE JAN. 12 number appears an article dealing with "Diesel Cooling-Water Systems."

In one paragraph the author writes, "As, with a lime-soda softener, the cold process must be used, the hardness in the water will not be reduced to less than 5.0 gr. per gallon."

I should like to refer the author to Bulletin No. 219 of the Engineering Experiment Station of the University of Illinois, published in 1930, which shows, on page 90, the results that can be obtained in efficiently operated lime softening installations. Samples of water taken from a number of cold-process softeners were submitted to the University of Illinois for analysis and the highest residual hardness obtained in any one instance was 18 p.p.m., or approximately 1.0 gr. per gallon. The lowest residual hardness in any one sample was 9.3 p.p.m., or 0.55 grain.

It is now common practice to treat for and obtain a hardness of 1.0 gr. or less in cold softeners without going to a high excess of overtreatment.

Chicago, Ill. H. A. GUSTIN,
Assistant Director of Service,
National Aluminate Corp.

Dual Firing for Peak Loads Effects Considerable Saving

AN EDITORIAL in the Dec. 15, 1931, number under the heading "Dual Firing for Peak Loads," reads something like this: "A prominent European engineer some time ago proposed a novel boiler arrangement for systems having high peak loads. This involved large boilers with suitably sized furnaces equipped for dual firing with stokers and pulverized coal." There are several such plants in New York State. In this plant, of which I am plant engineer, we have "Dual Firing" in a small way.

We have three water-tube boilers of 1,530 sq.ft. each. In 1929 these boilers were arranged for hand-fired shaking grates with Dutch-oven fronts. Then a unit known as an automatic furnace was installed for each boiler. This unit breaks the coal up fine enough to be blown through pipes into the fire, about 45 per cent of which is broken up fine enough to be burned in suspension, 50 per cent falls to the shaking grates and is burned, the remaining five per cent is hand fired.

The automatic furnaces are each driven by a 3-hp. motor at a constant speed while the coal is fed to the fan or paddle wheel by two small screw conveyors, the speed of which is controlled by a ratchet and pawl. The machine has an automatic control which cuts the motor off when the steam pressure reaches the high point (in this case 158 lb.) and starts again at 155 lb., the radiant heat from the fuel bed igniting the coal in suspension.

To prevent this intermittent shutting down we later installed an electrically actuated compensated damper regulator which controls the damper in the main flue, also the speed of the screw conveyors thus controlling the coal feed and the air to the paddle chamber. With this control the machines can be run continuously.

This system has resulted in a considerable saving in the cost for coal and repairs, also we have been able to burn a lower priced coal, with better steaming conditions due to steadier firing.

Twelve per cent CO_2, plus, is maintained. This system of firing has proved satisfactory in every way.

An accurate account has been kept of operating costs of this system and the underfeed stokers previously used and the saving over a year's period amounts to around $9,000.

The equipment gives us a flexible boiler plant. We can generate 9,000 lb. of steam per hour per boiler with ease, and on occasions have carried 12,000 lb. each boiler which is close to 250 per cent of normal rating.

Syracuse, N. Y. T. A. HAM,
Plant Engineer,
Onondaga Pottery Company.

Economy Must Not Be Neglected In Power-Factor Improvement

WITH a power factor of 78 per cent, as mentioned by O.R. in Jan. 19 number, if the alternators are fairly well loaded the temperature of their field windings may become dangerous because of the increase in excitation current necessary to maintain normal voltage. Assuming the system to be controlled by a voltage regulator, attention should be given to the proper adjustments of the inductive compensators and to the correct positions of the generator-field rheostats. In case of excessive voltage drop, or variation in voltage due to sluggish regulation, especially at low power factors, the use of a pilot exciter for supplying excitation to the main exciter fields, shortening of the exciter-pole air gaps, paralleling of the exciter field coils or increasing the rotative speed of the exciter are all factors which will affect the response of voltage regulation. These adjustments, of course, should be made regardless of power-factor conditions, but at the low power factor mentioned they are of vital importance.

If synchronous motors happen to be operating on the system, it may be possible to increase their excitation current, providing that the field-coil temperatures remain within safe limits. In one plant with a spare unit the generator was uncoupled from its prime mover and floated on the line as a synchronous condenser. In another we left the coupling intact, the turbine being driven at speed by its generator while serving in the capacity of a condenser. In this case a small quantity of steam was bypassed around the throttle to avoid overheating the turbine blading. E. F. CARLSEN.

Lebanon, Ohio

READERS' PROBLEMS

SIZE OF CONDUCTORS REQUIRED FOR LIGHTING LOAD—*What is the best method of supplying current over a two-wire 220-volt direct-current circuit, a distance of 1,367 ft. one way, to a lighting load of 430 amp.? The allowable drop in the line is to be held at 2 per cent at full load. The power plant to which this load will be connected is now supplying other loads near by. These lines have been calculated on a maximum voltage drop of 2 per cent.* V.A.C.

If the voltage drop in the line is to be held within 2 per cent, then the only thing that can be done is to put in copper large enough to meet this specification. A 2 per cent drop in a 220-volt circuit is equal to $220 \times 0.02 = 4.4$ volts. The size of the conductors is calculated by the formula:

$$C\,M = \frac{21.5\ LI}{E_d}$$

where $C\,M$ equals the size of conductors in circular mills; L the length of the circuit in feet one way; I the load in amperes; and E_d equals the allowable volts drop in the line. In this problem

$$C\,M = \frac{21.5 \times 1{,}367 \times 430}{4.4} = 2{,}872{,}079,$$

say 3,000,000 circular mils.

There are a number of possible ways that the size of the conductors may be reduced, depending upon local conditions. It may be possible to plan the distribution system so that the load centers near the generating station can be operated at a higher voltage than one that is farthest away. For example, it may be that the system can be planned to operate the near-at-hand centers at 230 volts and the one farthest away at 220 volts.

This would allow a drop of about 15 volts in the long feeder, assuming that the voltage would be about 2 per cent below normal, at the load center farthest from the plant, at maximum load. Allowing 15 volts drop in the line, the conductors need have only 750,000 circular mils cross section. To do this successfully, pilot wires should be run to the power house from the distant load center and from one of the load centers near the plant. These pilot wires are to be connected to the voltmeter switch so that the operator can adjust the voltage to maintain as near as possible the correct value at the load centers.

If the distant load is one that has to be supplied at infrequent periods it may be possible to connect this load to a separate generator in the plant. If this can be done then practically all the difference between the maximum voltage that the generator will produce and that required at the load center may be allowed as drop in the line. Assume that the generator when supplying a 430-amp. load will deliver a maximum of 245 volts. Then a line drop of 245-220 = 25 volts may be allowed. In this case the size of the conductors could be reduced to 500,000 circular mils, which is about the smallest size that can be used if the conductors are to be installed in conduit.

Another solution to the problem is to install a series booster in the feeder running to the distant load and supply this load from the power house busbars. If the conductors have weather-proof insulation and are installed in the open, 350,000-circular mil wire may be used. With this size wire the volts drop in the line, with a load of 430 amp., will be 35.5 volts, and a booster will have to be provided to raise the voltage by that much under maximum load.

Which of these suggestions will prove the most economical will depend upon local conditions. The longer the period, during a year, that the load will be supplied the greater the investment can be justified in the conductors to keep down line losses.

COMPOSITION OF BRASS PIPE—*What is the metal mixture of brass pipe?* F. H.

Brass used in making pipe is a zinc-copper alloy, carrying a small percentage of lead or tin to make the metal easier to work. For commercial pipe the proportions are: copper, 60 per cent, zinc, 39 per cent, lead, 1 per cent. A better grade of pipe is made up of 66 per cent copper, 33 per cent zinc and 1 per cent lead. This is sometimes called 22 to 21 brass. Red brass, a superior product, is composed of 85 per cent copper, 14 per cent zinc and 1 per cent lead.

Copper pipe is composed of 100 per cent commercial copper; which, however, carries a slight amount of other materials.

In purchasing brass pipe one should insist on pipe that is thick enough to take a full-depth thread.

DETERMINING PUMP DISCHARGE—*I understand that in figuring the discharge of a centrifugal pump a nozzle test is used. How is this done? How are the nozzles made and what is their general shape inside? Could you explain this system fully and how to make the nozzle?*

Where could a table giving the various discharge of different-sized nozzles, from, say, $\frac{1}{8}$ to 4 in., and pressures from 5 to 160 lb., be obtained? C.C.

A usual method of calculating the discharge of a pump is to employ an orifice in a tank into which the pump discharges and in which the head of water above the orifice is kept constant. The formula used is $q = Ka\sqrt{2gh}$, where

q = Volume of water in cubic feet per second.

K = A constant to compensate for the fact that the quantity is less than the theoretical and the effective area is less than the orifice area. K is usually about 0.6.

a = Area of orifice in square feet.

g = Acceleration due to gravity, 32 ft.

h = Head of water above the orifice in feet.

It is necessary to calibrate the orifice if close results are desired. This can be done by measuring the volume of water passing in a given period. Data on orifices are given in Marks' Handbook, published by McGraw-Hill Book Company.

It is possible to obtain close results by connecting a fire hose to the pump discharge, noting the pressure registered at the nozzle coupling. In "Hydraulics," by Hughes and Safford, is a table giving the discharge of various diameter fire nozzles under various pressures; however, if you desire close results you should calibrate the nozzle by measuring the actual volume of wate. passing in a given time under a given head. With the quantity per second thus known the coefficient K can be ascertained by substitution in the formula:

$q = Ka\sqrt{2gh}$, remembering that a is in terms of square feet and h the head is the pressure obtained at the base of the nozzle by means of a Pitot tube multiplied by 0.433.

Readers Agree That Precooling Will Pay

WE OPERATE a 100-ton motor-driven ice plant. Condenser make-up and can water is obtained from a drilled well; the summer water temperature is about 45 deg. F. Would we be justified in pumping enough of this water to precool the ammonia. Power costs 3c. per kilowatt-hour and the water must be lifted 270 feet. L.M.L.

ASSUME THAT the average condenser and suction pressures are 138 lb. and 23.8 lb. respectively. From the Bureau of Standards tables the liquid temperature corresponding to 138 lb. pressure is 80 deg. F. Referring to Table XIX of "Principles of Refrigeration," by Macintire, it is found that for these pressures (138 lb. and 23.8 lb.) the weight of ammonia that must be cir-

culated per minute per ton of refrigeration is 0.414 lb.

For the average plant the factor of 1.7 tons of refrigeration per ton of ice will ordinarily hold true. We then have:

	Tons of refrig.
100 tons of ice × 1.7 =	170
Assumed daily storage load =	5
Total	175

The ammonia circulated per minute will then be:

$$0.414 \times 175 = 72.5 \text{ lb.}$$

The liquid is cooled from 80 deg. to 50 deg., a difference of 30 deg. From the ammonia tables the average specific heat of the liquid is obtained as follows:

Specific heat at 80 deg.	1.138
Specific heat at 50 deg.	1.112
	2.250
Average specific heat	1.125

The heat to be removed per pound is then:

$$30 \times 1.125 = 33.75 \text{ B.t.u.}$$

The corresponding heat to be removed per minute is:

$$72.5 \text{ lb. } NH_3 \times 33.75 = 2{,}450 \text{ B.t.u.}$$

The next step is to determine the water that must be pumped and the power required to handle it. With the water temperature rising from 45 deg. to 55 deg. or 10 deg. difference, the water circulated to remove 2,450 B.t.u. per minute will be:

$$2{,}450 \div 10 = 245 \text{ lb. per min.}$$

This equals:

$$245 \div 8.33 \text{ lb. per gal.} = 29.4 \text{ gal. per min.}$$

Allowing a total head of 300 ft. (270 ft. lift plus 30 ft. friction), the theoretical power required to handle 245 lb. per minute will be:

$$(300 \times 245) \div 33{,}000 = 2.22 \text{ hp.}$$

Allowing 70 per cent pump efficiency and 87 per cent motor efficiency, the electrical input will be:

$$2.22 \div (0.70 \times 0.87) = 3.65 \text{ hp.}$$

$$\text{or } 3.65 \text{ hp.} \times 0.746 = 2.72 \text{ kw.}$$

Operating 24 hours, at three cents per kilowatt-hour, this will cost:

$$2.72 \times \$0.03 \times 24 = \$1.96 \text{ per day,}$$

or say $2.00 per day for pumping. Allowing 200 B.t.u. per minute per ton of refrigeration, the 2,450 B.t.u. removed per minute by the water will increase the available refrigeration by:

$$2{,}450 \div 200 = 12.2 \text{ tons}$$

Assume that the plant operates on 50 kw.-hr. per ton of ice, and that 1.75 tons of refrigeration corresponds to one ton of ice. Then:

$$12.2 \text{ tons refrig.} \div 1.75 = 6.96 \text{ tons ice.}$$

This increases plant capacity to 107 tons, approximately.

For 100 tons of ice under the present setup the power cost will be:

$$50 \text{ kw.-hr.} \times 100 \text{ tons} \times \$0.03 = \$150 \text{ per day}$$

Adding the computed $2 pumping cost, the cost of producing 107 tons under the proposed setup will be $152 per day.

The savings can be found by figuring the cost of producing 107 tons of refrigeration on the basis of 50 kw.-hr. per ton of ice as in the present 100 ton plant. This will be:

$$107 \text{ tons} \times 50 \text{ kw.-hr.} \times \$0.03 = \$160.50 \text{ per day}$$

The net saving in power cost will be:

$$\$160.50 - \$152.00 = \$8.50 \text{ per day.}$$

On the basis of 100 per cent load factor, operating 365 days per year, this would amount to approximately $3,100 per year.

Assuming that there are no serious obstacles in the way of installing a properly designed liquid cooler, this installation would prove to be a very profitable investment and pay for itself in a very short time.

HERBERT N. ROYDEN.

Los Angeles, Cal.

—◆—

L. M. L. WOULD save about $13.50 a day by pre-cooling the ammonia liquor with the well water provided he has the equipment to do it with.

The amount saved can be calculated fairly accurately by substituting actual values for the following conditions which have been assumed as reasonable and practical to correspond with the information included in your statement of the question.

With brine at 15 deg. F. the evaporator temperature is probably about 5 deg. F. and the suction gas is probably superheated to about 10 degrees. This information determines the heat content of the suction gas needed for the calculation.

If the summer temperature is 90 deg. dry bulb, and 80 deg. wet bulb, the condenser water is probably cooled to 83 degrees. The temperature of the liquid ammonia leaving the condenser will be about 5 deg. higher, or 88 deg. This corresponds to a head pressure of 160 lb. gage and non-condensable gas in the system will increase the total head pressure to about 165 lb. gage.

With these figures the power consumption per ton can be calculated. The total power cost have been estimated on the assumption that in this plant 1.6 tons of refrigeration produce one ton of ice and that the overall efficiency of the compressors and motors is 70 per cent.

Using the Bureau of Standards Mollier chart for heat content values, it is calculated that the power consumption without pre-cooling the liquid ammonia is 1.99 kw. per ton.

If he can pump enough water to pre-cool the liquid to 55 deg. the temperature of the water leaving the pre-cooler would be about 50 deg., a 5 deg. rise above the water temperature.

With a liquid ammonia temperature of 55 deg. F. the power consumption would be 1.84 kw. per ton. The decrease in power used is therefore 0.15 kw. or 3.60 kw.-hr. per ton. When the plant is making 100 tons of ice in a day, the total saving in compressor power would amount to 576 kw.-hr., or $17.28.

The weight of pre-cooled ammonia required would be 0.389 lb. per minute per ton or a total of 62.24 lb. per minute. The heat removed from this quantity of liquid in cooling from 88 deg. to 55 deg. is 39 B.t.u. per lb., or a total of 2,427 B.t.u. per minute. This is equivalent to 485.4 lb. of water per minute if the temperature rise is 5 deg. F. as assumed above.

It is further assumed that the 270 ft. lift is the total head on the water supply and not simply the depth of the well. Using a pump with an overall efficiency of 60 per cent, the additional power consumption for pumping the pre-cooling water would be 218,000 ft.-lb. per minute or 4.93 kw.

When the plant is making 100 tons of ice the power used would be 118 kw.-hr. and the cost $3.54. The net saving expected from pre-cooling would, therefore, be $17.28 minus $3.54 or $13.74 per day when operating at full capacity under conditions as stated above.

If figured on an annual basis the savings would be much less than this calculated value, depending on the load factor, the degree of variation in all of the conditions affecting the performance of the plant, and the amount of money required to modify the equipment or make the necessary changes in piping for pre-cooling the liquid.

K. M. HOLADAY.

Springfield, Ill.

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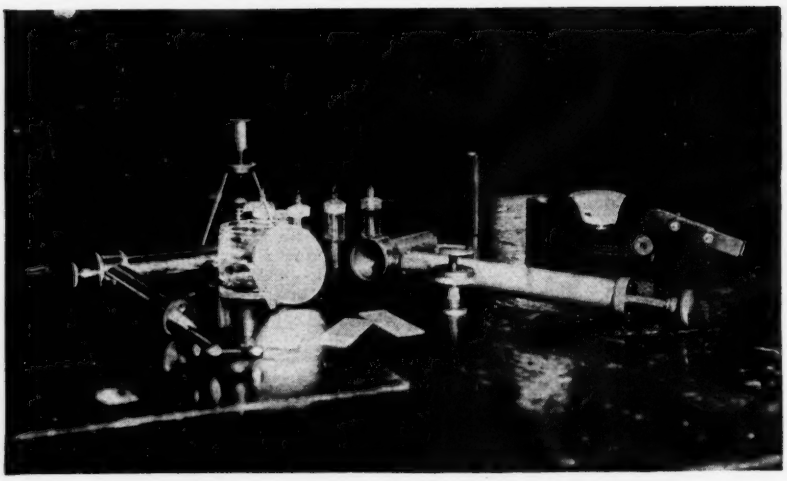
A Question for Our Readers

WE HAVE *a four-story factory with no basement, with the exception of the boiler room, which is in a small basement of its own in the rear. The return lines from the heaters to the vacuum pumps are all easily accessible, with the exception of one 1½-in. line. This line is the return from the offices and a few heaters in the front of the factory. It is under the floor and cannot be seem without breaking up the floor, which happens to be concrete. We cannot pull any vacuum on the system, and have traced it to a leak on this line from the offices. Can some one suggest a way of finding this leak without going to the trouble of tearing up the floor?* G.W.L.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.



Various devices for sampling air and field inspection of samples were demonstrated by Doctor Free

SMOKE Under the Microscope at A.I.E.E. Meeting

E. E. Free demonstrates latest methods of sampling and inspecting smoke and reports that utility plants are responsible for less than 5 per cent of New York City total. Other speakers disagree that domestic plants are primary offenders.

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BOTH literally and figuratively, smoke went under the microscope at the meeting of the New York Section of the American Institute of Electrical Engineers on the evening of March 8. Dr. E. E. Free, consulting engineer and professor at New York University, supplied the instruments and the motive power of the discussion. His analysis of the smoke problem drew commendations for his scientific work in this field, and both agreement and disagreement with his conclusions.

Dr. Free, as the only scheduled speaker, demonstrated interesting facts about smoke, using the projection microscope, the direct-reading electric photometer, and various other appliances for inspecting and studying this nuisance in its solid particle phases. The most striking conclusion offered by Dr. Free, which he stood ready to prove at any time by scientific data, was that, in New York City at least, the stacks of utility steam and electric plants and of large factories are not the primary offenders. More than 90 per cent of the smoke nuisance, declared Dr. Free, comes from apartment houses, homes and other small users of fuel.

This conclusion was strongly confirmed by some speakers in the discussion, and denied with equal insistence by others.

The meeting revealed considerable difference of opinion, not only as to the primary sources of smoke, but as to the constituents of smoke which are primarily detrimental. Some considered carbon the chief offender, both as a direct nuisance and as a filter removing beneficent ultra-violet light. Others named as the primary culprit the silica-bearing ash particles said to lodge in lungs and lead to pulmonary disorders.

All agreed that wind is an important factor in determining the degree of smoke nuisance from day to day, and that improvements recently noted in New York are the combined effect of many factors, among which are the drive on smoke offenders, a mild winter with consequently reduced coal consumption and lowered industrial activity.

Dr. Free Demonstrates Sampling and Testing Apparatus

Dr. Free prefaced his remarks with comments on the difficulties of the problem. In the field of smoke measurement, he said, there is a lot of guessing, some good and some bad. The problem is to reduce the indefinable nuisance, of which people complain, to measurable terms. Much scientific work has been done, and methods of practical value have been developed, said Dr. Free, although none of them achieves the precision desired by physicists.

In the collection of samples he referred to the old plate method, in which the plates are covered with a sticky substance to collect dust, as antedated and of little value because such plates "select" certain kinds of particles and let others pass.

At present, according to Dr. Free, two sampling methods have scientific standing. The first is the filter method, in which the air to be tested is drawn at a definite rate through filter paper, producing a discoloration which may be approximately measured as an index of smoke concentration. While this is perhaps the best of the quantitative methods, it gives no information as to the character of the smoke particles. In addition, therefore, Dr. Free uses in his work the jet or impact counter method in a form modified from the original apparatus of Dr. Owens, the English pioneer.

Air drawn in through a small orifice by a hand pump is allowed to impinge on the cover glass of a microscope slide, producing a spot of smoke deposit, which is examined under a microscope.

Another method, extremely simple, employs a cover glass supported near the bottom of a small glass jar. The jar is opened to admit a sample of the air being tested. The jar is then closed and the particles in the air allowed to settle on the glass for a long period, after which the deposit may be studied under the microscope.

On the clearest day, said Dr. Free, one cubic foot of city air will contain about 50,000 particles per cubic foot. This may increase to 3,000,000 particles on the smokiest day. For the past five years, in New York City, the average has been about one-half million, perhaps reducing to about 300,000 in recent months, due to conditions already mentioned. This is equivalent to about

one ounce of soot per 12,000,000 cu.ft. of New York City air.

Contrary to popular opinion, Dr. Free stated that rain and snow have little effect in clearing the atmosphere of smoke particles (other than cinders). Wind, on the other hand, has a marked effect in diffusing these particles over great areas, and in driving smoke toward or away from the point where the tests are made.

For example, he pointed out, Manhattan Island, the heart of New York City, is relatively free from smoke when the wind is from the northwest, blowing over a thinly populated district. The southwest wind, on the other hand, brings much smoke from the nearby thickly populated districts of New Jersey. Complete lack of wind, moreover, leaves the local smoke stationary over the city, and greatly increases the nuisance.

The Ultra-Violet Photometer

Among the instruments demonstrated by Dr. Free were radiation photometers for ultra violet light as well as ordinary sunlight. Radio tubes are used to amplify the current of the photo-electric cell.

Records kept over a period of years show a close correspondence between the readings of these instruments and the amount of smoke present in the atmosphere. However, Dr. Free pointed out, the filtering out of ultra-violet radiation or ordinary sunlight is influenced not only by the actual weight of smoke, but by the flocculation of small particles into large. This latter effect depends to an important extent upon the nature of the smoke involved.

While admitting the probability that ultra-violet light has an important effect upon health. Dr. Free insisted that investigation has shown no correlation whatever between death rates in various sections of the country and the amount of ultra-violet radiation present. There are too many other factors involved, he said, to make the death rate of any value in such studies. Further study in different directions is needed to demonstrate the true value of ultra-violet light. Passing by this factor, Dr. Free pointed to the known and obvious bad results of smoke, such as damage to buildings, increased laundry bills, etc.

As the first step in attacking the smoke problem, he listed finding out where the smoke comes from. Some years ago he concluded that domestic and other small furnaces, rather than those of large electric and district steam utilities and large factories, are the prime offenders. With these domestic chimneys he grouped tug boats in the New York Harbor (including Hudson and East Rivers) as a primary factor. Taken together, he said, they account for from 90 to 95 per cent of all the smoke nuisance.

Among domestic users Dr. Free included apartment houses, in which a large part of Manhattan population lives.

Two reasons were given for the greater smoke from domestic fires. One was the very large number of such users, and the other was the fact that most of them are so small that the janitors or other firemen operate without sufficient instruction or pressure to eliminate smoke. On the other hand, smoke from a few large stacks is a signal insuring immediate and drastic action.

Sherlock Holmes, according to Conan Doyle, tracked criminals by the analysis of cigar ashes. Applying a similar method, Dr. Free has been able to identify plants from which certain smoke particles have originated. He did this, as explained in his lecture, by studying the shape and character of carbon and ash particles at given plants, and at distant air sampling stations. Using this system of identification, he is able to tell what proportion of smoke collected at a distant station originated at the plant under consideration.

On the platform a microscope was connected up with a stereopticon for projection, and various types of smoke particles were demonstrated on the screen. Among these were globular spheres of ash and small slivers of carbon. A ruled plate is used for counting the smoke particles.

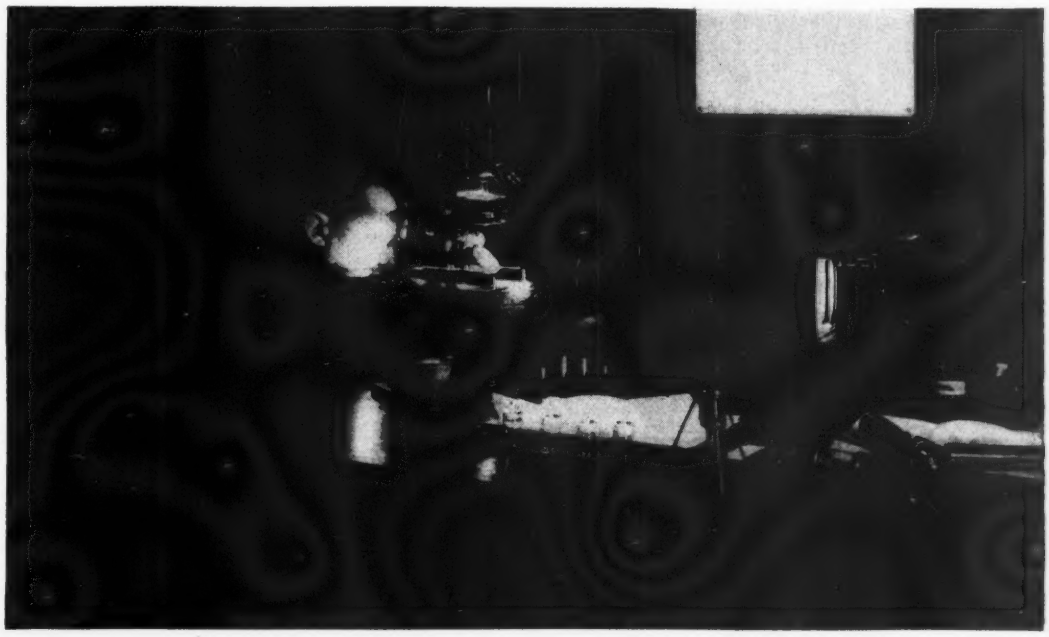
Dr. Free congratulated the city health department and other agencies, as well as the large power houses, on excellent work in the reduction of the smoke nuisance. He felt that little further improvement could be made, since uneconomic expenditure of money would be necessary for further improvements in the large plants, and since the domestic and other small fires are hard to get at.

Whitlock Commends Free but Disagrees

Since June, 1930, Col. Elliott H. Whitlock has been studying the smoke problem of the New York metropolitan district, particularly on the New Jersey shore, under the auspices of Stevens Institute. In discussing the paper, Colonel Whitlock commended Dr. Free's work as scientific pioneering in advance of current practice. Such work is needed as a yardstick to measure the accomplishments of those more immediately concerned with the pressing problems of smoke prevention.

But Colonel Whitlock disagreed with Dr. Free's conclusion that the larger plants are minor offenders. Particularly at times of peak load, he said, much smoke is emitted from such stacks. The conclusion he drew was that while the heat-absorbing surfaces of large station boilers may be large enough for peak loads, this is not true of the firing equipment and furnaces.

Stack carbon, said Colonel Whitlock, is not a by-product of combustion, but is an absolute waste, which should have



Dr. Free combines stereopticon and microscope to project smoke particles on screen at meeting

been consumed to carbon dioxide inside of the combustion chamber. The cure for this situation is chiefly a matter of a large enough furnace.

Colonel Whitlock told of many cases where smoke offenders, under pressure, increased combustion spaces by lowering the furnace floor and then made a substantial saving as the unexpected result. In most of these cases the investment paid its cost in three years.

Four Years of Smoke Records

Dr. David R. Morris, of the United States Observatory in Central Park, New York City, told of four years' smoke records made at his station. Recently he has used the Owens' filter, giving a continuous record automatically, and showing the daily and monthly rise and fall in smoke quantities.

His curves showed a primary smoke peak at 8 a.m., and a secondary at 8 p.m., a primary valley at 3 p.m., and a secondary at 4 a.m. He pointed to the very important effect of the wind velocity and direction.

In 1931, he said, the pollution was about half that in 1930. For this he listed a variety of causes, including the business situation, the reduced consumption of soft coal relative to hard coal, and the mildest winter in 63 years as well as the strenuous efforts of smoke prevention agencies.

Dr. Morris found that the ash was about double the carbon in the samples collected. With high concentrations he feared that silica in such ash might lead to the disease known as silicosis. Carbon smoke, he pointed out, filters out ultra-violet light, which is essential to the proper growth of children.

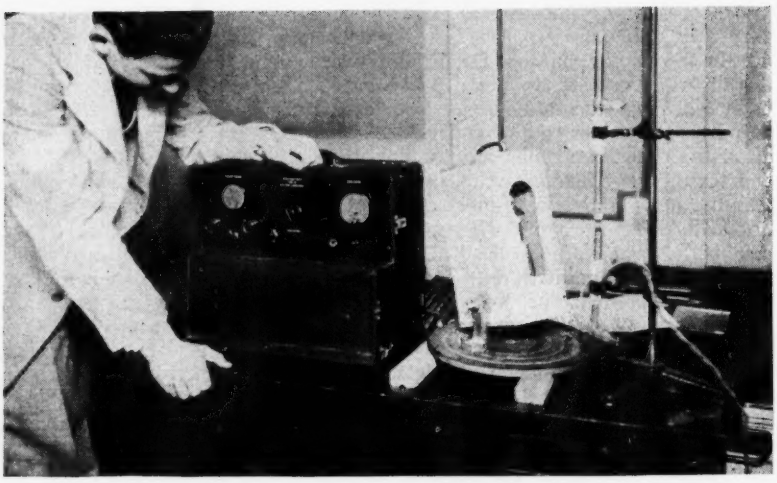
Dr. Darlington Tells of Smoke Inspector's Tribulation

One high light of the meeting was a vigorous discussion presented by Thomas Darlington, M.D., who heads up the smoke prevention activities of the city department of public health. "All smoke can be stopped," said Dr. Darlington. Antiquated court traditions make it difficult to get at smoke offenders, however. The courts hold that it is unconstitutional to say what people shall or shall not burn. The law, according to the courts, can only forbid the resulting nuisance.

As a result of more than 18,000 inspections, the smoke emitted by all types of plants in New York City has been reduced more than 80 per cent. This improvement has been particularly noticeable in the domestic fields.

Challenging Dr. Free's statement, Dr. Darlington insisted that the large steam and electric plants are now the chief offenders. He said that he would like to take them into court, but hesitated to do so because the loss of a single large case might result in all of the small plants going back to smoky chimneys.

It was Dr. Darlington's conviction that owners and boards of directors are generally too indifferent to stop smoke nuisance just because of the loss involved. Fear of arrest is the only effective force. "But you cannot arrest a corporation," he pointed out.



Demonstrating ultra-violet photometer with aid of arc light. Photo cell is in the tilted case

Concluding his discussion, Dr. Darlington declared that the engineers of the United States should get together and say "We need not have any smoke." Thus, backed by technical opinion, public health bodies could make real progress in the solution of this problem.

Says Women Demand Clean Air

Women's organizations have been powerful factors in cleaning up sources of contamination in public supplies of water and milk. With these menaces now greatly reduced they are on the trail of city smoke. Their militant spokesman at the meeting was Miss Laura A. Cauble, Home Economics consultant.

Each of us must breath 35 lb. of air per day, she said, with "little to say about what goes into it." She challenged the authorities to "face the facts now," saying that women will grant a reasonable time for improvements to be made effective, but will stand pat on the platform: "Smoke can be stopped." It may cost money to stop smoke, she said, but the housewife now pays yearly the equivalent of a month's rent in damage and work caused by smoke. In any case health counts more than expense, she concluded.

Another speaker said that the small smoke particles (about 1 micron in diameter) fall only 30 ft. in 10 hours, during which time they would be blown 100 miles by a moderate breeze.

Still another speaker in the discussion summed up the answer to the smoke problem as "ample furnace volume plus even firing." He said the small chimneys in the aggregate are a serious problem because of faulty design and careless operation.

Stating that he held no brief for the utility plants Ely C. Hutchinson, editor of *Power*, said that the importance of domestic and other small furnaces as smoke makers should not be overlooked. The difficult problem, he said is to educate those responsible for the installation and operation of small boiler plants. "It might perhaps help if the rudiments of combustion were taught in public, night and vocational schools."

Mr. Hutchinson referred to the pressing need for a standard definition or measure to evaluate smoke in relation to its detrimental effect on health. Here, he said, is a clear call for cooperation between physicians and engineers. Each has a distinct job; the doctor to tell what is harmful and the engineer to tell how to stop it.

Another speaker said that ash in smoke was the most difficult constituent to eliminate and that it, as well as carbon, cut down the ultra-violet radiation. He felt that ash particles from large plants are generally less damaging to the lungs because the larger furnaces operate at higher temperatures which fuse the sharp particles into round globules.

Answering the call for a yardstick, Dr. Morris announced that the U. S. department of public health is conducting a general survey of smoke in ten cities. This exhaustive study will take several years to complete and may well lead to a definite smoke measure correlated with nuisance value and danger to health.

In his closure Dr. Free said that, in his local studies, in and about New York, he had found smoke to contain about one third ash rather than two thirds as reported by Dr. Morris. For the microscopic study of smoke he preferred a magnification around 500 diameters. The cinder problem, he said has been largely solved in New York.

Dr. Free repeated and strongly emphasized his previous statement that domestic smoke is 90 per cent of the total, and that less than 5 per cent of the smoke in New York city comes from utility plants. He said that smoke must unfortunately be judged legally on the basis of its visibility although invisible smoke is far more important.

The whole problem, he concluded, is one of money. Complete elimination of smoke in New York would add 25 per cent to the cost of living. Addition expenditures imposed on corporations must necessarily be passed to the consumer.

WHAT'S NEW IN PLANT EQUIPMENT

Improved High-Capacity Steam Trap

HIGH CAPACITY and simplicity feature the free-floating lever steam traps developed by the Armstrong Machine Works, Three Rivers, Michigan. The new trap uses the inverted-bucket principle characteristic of the Armstrong line.

Referring to the illustration, the valve lever loops over two guide posts at one end and engages the bucket hook at the

View showing operating mechanism of Armstrong trap

other. When the bucket floats, it pushes directly against the valve stem, forcing the valve to its seat, where it is held by the steam pressure within the trap. Water entering the inverted submerged bucket causes it to lose its buoyancy and exert a pull on the end of the lever, the valve opening as soon as the weight of the bucket multiplied by the high leverage is greater than the pressure holding the valve against the seat. When opening, the valve lever fulcrums on the knife edges, which bear directly on the valve seat.

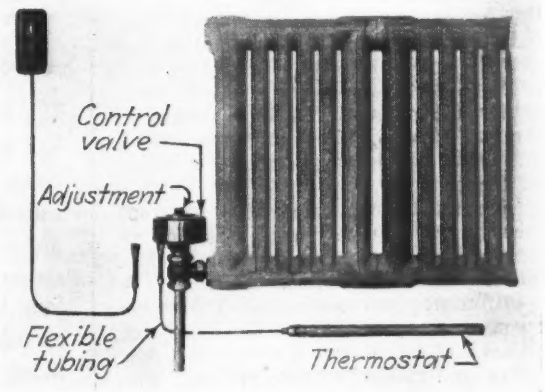
The use of a high leverage for opening the valve and a direct 1-to-1 lift for closing tends to prevent excessive wear on the operating mechanism. Substituting knife edges for the conventional pivots largely eliminates friction and also makes it possible to open larger-diameter orifices at a given pressure.

The new traps have heat-treated chrome steel valve parts and are furnished in cast semi-steel for pressures up to 250 lb. In the forged-steel pattern the traps are available for 600, 900 and 1,500 lb. pressure service with any degree of superheat. In addition, the new line includes compound traps for handling large volumes of water at any pressure and special traps for pulsating pressure conditions.

Thermostatic Radiator Valve for Steam Heating System

EMPLOYING the same principle as the Powers standard regulators the new thermostatic radiator valve announced by the Powers Regulator Company, 2720 Greenview Ave., Chicago, is designed for use with direct, indirect or concealed radiation of vapor vacuum heating system. It has a sensitive thermostat that is located outside of the radiant-heat zone of the radiator and does not operate on a radiator temperature differential as in many designs.

The valve control consists of a diaphragm-operated valve connected by armored flexible tubing to a thermostat which is available in two styles: one encased with a thermometer for wall mounting and the outer a tubular shaped element for use with concealed radiation, unit heaters and wall type radiators.

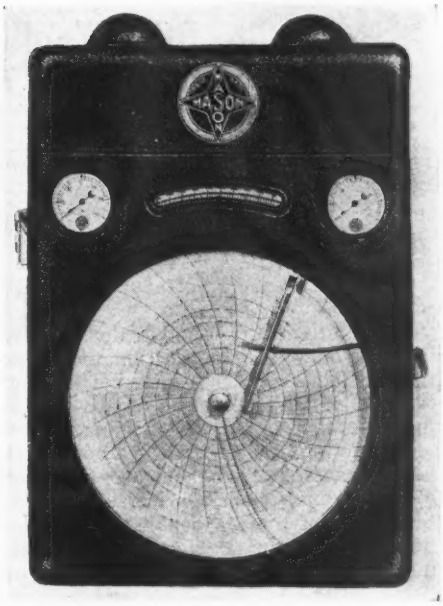


Powers Thermostatic radiator valve shown with wall- and tubular-type thermostatic elements

It is claimed by the manufacturer that the close regulation obtained with this control is due to the larger sensitive surface of the thermostat, which is influenced by room temperature and to the greater area of diaphragm bellows used to open and close the valve. Sizes of the valve range from ½ in. to 2 inch.

Pressure Control Instruments for Process Industries

THE DEVELOPMENT of a new line of pressure control instruments for all process industries has been announced by the Mason Regulator Company, 1190 Adams St., Boston, Mass. New



Mason pressure instrument

features of design are embodied in these instruments, providing greater precision in control and at the same time simplified adjustment.

One of the important improvements in these controllers is the Rota-Port Synchronizer which enables the instrument to be instantly synchronized with the speed of any process. It is pointed out by the manufacturer that through a new principle in design these instruments supply the straight-line function. That is, for every increment of movement of the control element there is a definite and uniform increment of movement of the diaphragm valve controlling the pressure.

NEWS of the FIELD

N. Y. Utility Bills Would Increase Control of Stock Interests, Rates and Management Charges

A SERIES of seven bills, representing the Democratic policy as to public utility supervision and regulation, have just been introduced in the New York State Legislature.

The first measure amends Section 110 of the Public Service Law by changing the definition of "affiliated interests" to include holding of 5 per cent of voting capital stock of a utility corporation instead of 10 per cent as at present. It provides that no charge for management, construction, engineering or similar service shall exceed the reasonable cost of performing such service. Any sums in excess of the reasonable cost, as determined by the Public Service Commission, shall be repaid directly or "deemed not to have been paid."

Adding new sections to the law, the second bill permits municipalities and groups of consumers to appear at any hearing or proceeding involving rates or services, while the third act provides that the Public Service Commission shall not approve any rates and charges yielding return in excess of reasonable profit on the rate base or fair value of the property used and useful in public service, over and above reasonable operating charges. Such reasonable return shall be computed by taking the sum of the annual fixed interest charges and fixed dividend requirements and a reasonable rate of return on the equity represented by the remaining stock, such equity being measured by subtracting the par value of the outstanding stock and indebtedness from the fair value of the property.

The fourth bill empowers the commission to require issues or sales of stocks, bonds and notes to be by public bidding after due notice.

Different plans to accomplish the same purpose are proposed in the last three bills, all of which would establish a new policy and method of rate making. The fifth bill provides for contracts affecting certain types of public service, to be entered into between persons or corporations furnishing such service with the Public Service Commission acting as agent for the State. The sixth bill differentiates as to rate base between property heretofore and hereafter acquired, while the seventh measure calls for an initial state-wide valuation to determine a fair rate base upon which to compute a reasonable return.

In addition to the foregoing acts, a bill was introduced, requiring all gas, electric and telephone companies to file new rates before July 1 showing a 10 per cent reduction under the prices charged on Jan. 1, 1932. The Public Service Commission is directed to start proceedings against each corporation that fails to file such a new rate schedule within 30 days after July 1, 1932.

Senate Strikes Out Sum for University Steam Plant

AFTER HAVING been informed by the Potomac Electric Power Company that commercial rates for electric power in Washington are less than the cost of production of small independent units, the Senate Appropriations Committee has stricken from the Interior Department appropriation bill an authorization of $300,000 for the construction of a heat, light and power plant at Howard University in Washington. The House allowed the appropriation for the heating and power plant. The claim was made by government engineers that it would be cheaper for the government to generate its own current for the university and an adjoining hospital than to purchase it from the power company.

In testimony before the committee, government engineers stated that power for the university could be generated for as little as a half a cent per kilowatt-hour. It was explained that this low cost would be made possible by the fact that the heating plant will be necessary anyway and that the same steam can be used for heating and the generation of electricity. Asked by members of the committee to state the rates that the power company would charge, a representative of the company replied that the rate would be something around a cent a kilowatt-hour. The statement was made on behalf of the power company that it is not quite correct to regard light and power as a natural byproduct of a heat plant. The committee was informed that the generating equipment and engines that would be necessary for the proposed power plant would cost approximately $123,000, including the cost of housing.

In connection with the rate offered by the power company, a statement was made by one of the government engineers that the company on several occasions has lowered the rate at a particular location at the time an appropriation for an independent power unit was being considered. There is a possibility that the Senate will restore the section authorizing the appropriation for the power plant. If this is not done the House must be pursuaded to recede from its position in the matter when the bill is taken up in conference, if the appropriation is to be finally disallowed.

INDEX NOW READY

The Power Index for the second half of 1931 is now ready. This covers all important articles published from July to December, inclusive. As in previous years, single copies of this index are furnished to Power subscribers on request, without charge, and those desiring to receive indexes regularly may have their names placed on this list by application. Many readers find that the index is very helpful when practical problems arise around the plant. Almost always it is found that Power has already published one or several articles bearing directly upon the matter in hand.

New York Senate Passes School Ventilating Bill

THE NEW YORK SENATE has passed and sent to the Assembly the Mastick bill amending the state education law in relation to plans and specifications for the construction of school buildings. The measure would change the construction specifications to read "proper ventilation" in schools instead of the more exact wording of the present law, which provides for "at least 30 cu.ft. of pure air every minute per pupil." It would also strike out the clause relating to "foul air."

This bill is similar to a measure introduced last year by Senator Mastick, which passed both houses of the Legislature and was vetoed by Governor Roosevelt. Ventilating engineers in the

state opposed the bill and acclaimed the Governor's veto a substantiation of sound engineering principles. Their attitude toward the new bill remains the same.

Demonstrations Given of Circuit-Breaker Performance

ON MARCH 2 at East Pittsburgh, Pa., before a distinguished group of engineers, trade-paper editors and industrialists the Westinghouse Electric & Manufacturing Company demonstrated its new line of de-ion air-breaker circuit breakers. This line of circuit breakers provides a flashless device for circuits up to 575 volts in buildings, homes, industrial plants and mines, heretofore served by the conventional type of carbon circuit breakers and fuses. The demonstration was preceded by a meeting at which several of the company's executives and engineers presented papers on the new circuit breaker.

Breakers of the new type are available in current ratings of 15 to 600 amp. The operating mechanism is arranged to provide quick make and quick break and the operator cannot control the speed with which it operates. The contacts are trip-free of the handle in all positions from full open to full close.

Two types of interrupters are used on these breakers. For voltages not greater than 125 volts direct current and 250 volts alternating current, a plate-type interrupter is employed. When voltages are in excess of these values a cold cathode de-ion interrupter is provided. In the plate-type interrupter the arc is magnetically whipped from the contacts onto the plate surfaces where it is broken into a number of short arcs, which due to de-ionizing action of the plates prevent re-striking after the current has passed through zero. The cold cathode interrupter magnetically draws the arc from the contacts onto a number of copper plates. As the arc passes to the copper plates, it is broken into a number of short arcs which are rotated in a circular path over the surface of the plates by a magnetic field until the first current zero is reached.

Under test a 225-amp. de-ion breaker wrapped in cotton batting, interrupted 10,000 amp. at 600 volts without even singeing the cotton fibers.

Minnesota N.A.P.E. Will Hold Power Show, June 22-23

HAROLD HERMANSON has been named head of the general committee for the 23rd annual Minnesota convention and power show of the National Association of Power Engineers which will be conducted in the Minneapolis Auditorium June 22 to 24.

William H. McDonough of St. Paul, president of the state association, will preside at the convention sessions. C. A. Nelsom, state secretary, Arthur Victor, A. R. Devens and Mr. McDonough are chairmen of subcommittees.

Officers of the association state that more than $1,500,000 worth of exhibits will be displayed by 300 exhibitors. About 5,000 engineers and visitors from Minnesota and other states are expected to attend the show.

A banquet will be served in the Curtis Hotel on the night of June 23 and the power engineers' annual ball will be conducted the night of June 24. Other social events include a theater party, bridge and luncheon.

OLDEST THREE-PHASE PLANT TO GO

Projected abandonment this year of the Mill Creek No. 1 hydro station of the Southern California Edison Company marks the passing of an historic installation, the oldest in the company's system. Built in 1893, it is the first generating plant designed for three-phase operation. A steam-engine-generator was added in 1896 to supplement the water wheels at low-water periods, and the station was rebuilt in 1899 and again altered in 1905 and 1920. It is now planned to replace the plant with a full automatic hydro unit in a small concrete building

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Start Work on Duluth (Minn.) Central Heating Station

GROUND WAS BROKEN at Duluth, Minn., and work started, the latter part of February on the new central heating station of the Duluth Steam Corporation.

This plant will contain four 6,000-sq.ft. boilers designed for 450 lb. per sq.in. In spite of this design pressure the plant is expected to operate at 150 lb. Each boiler will be equipped with a 5-ton unit pulverizer and tubular air-preheater as well as fly-ash and cinder eliminators. A small house turbine-generator will supply power for auxiliaries.

Year-round operation, supplying steam at 150 lb. to the business district and certain industrial and process uses is contemplated. The plant is expected to go into service in September of this year.

Denver, Colo., to Electrify Water-System Pumping Plants

DENVER'S municipal water system is to be electrified, displacing the present steam pumping plants. A contract, calling for complete changeover within two years, was signed March 1 by the water commission and Public Service Company of Colorado, which will furnish power for the project. Three of the city's pumping plants, now partially electrified by municipal generating plants, are to be supplied with current from company lines by April 1.

The entire program contemplates an expenditure of $1,500,000, to be paid out of earnings. This sum includes more than $1,000,000 to build new pipe lines and a retaining reservoir several miles south of Denver; and about $300,000 for installation of machinery, wiring and other equipment.

Under the new arrangement, peak loads, which ran as high as 5,000 hp. under steam, will be eliminated; also a standby water reserve is provided for. Electric pumps will be driven by synchronous motors which will result in 100 per cent power factor. Daily load factor, under the proposed setup, will be 90 to 95 per cent; and monthly load factors 80 to 85 per cent.

In addition to the $85,000 annual saving to the city (this amount estimated by C. C. Schrepferman, manager of the water department) the plan will provide electric load which the Public Service Company will be able to handle in off-peak periods. In summer the load is scheduled to approximate 2,000 hp., day and night; in winter about 500 hp.

High Temperature Metals Committee Announces Program

ANNOUNCEMENT is made by the A.S.M.E. - A.S.T.M. Jount Research Committee on the Effect of Temperature on the Properties of Metals of the perfection of plans for sponsored researches during the year 1932 at the Engineering Experiment Station of the University of Illinois and the Battelle Memorial Institute.

Contributions and pledges so far made cover only about half of the $20,000 needed for the proposed three-year research program of the committee, but the funds already made available by the Engineering Foundation, the National Electric Light Association, the American Petroleum Institute, the National Research Council and a group of alloy castings manufacturers through the Corrosion Resistant Alloy Founders' Division of the Steel Founders' Society of America, Inc., have made it possible to initiate activities and to continue work throughout the present calendar year. In the meantime, it is the hope of the committee and its sponsors that additional funds may be made available to carry on the work.

Work at the University of Illinois, under Prof. H. F. Moore, will relate largely to the endurance properties of austenitic nickel-chromium steels at different temperatures. This will be coordinated with creep tests at the Battelle Memorial Institute, under Dr. H. W. Gillett, as well as with studies at various industrial laboratories relating to the structural stability of these steels and the changes in various properties with time at high temperatures.

Japanese Power Companies Plan Large Hydro Projects

EXPANSION of electric power activities received impetus in Japan with the announcement that several of the leading power companies contemplated new construction programs, according to reports from Assistant Commercial Attaché W. S. Dowd, of the United States Department of Commerce, located in Tokyo.

A mountainous country, with relatively short, turbulent rivers, Japan is said to have unusual possibilities for the development of power facilities, it is stated.

The Toho Electric Power Company has completed plans for the construction of the Sunmatakawa power plant to generate 65,000 kw. The Yasaka Hydro-Power Company, a subsidiary of the Daido Power Company, also is planning to build the Taihu Power plant to generate 60,000 kw. The Nippon Electric Power Company has completed its plans for the construction of the Kanetsuri power plant on the Kurobe River with a capacity of 72,000 kw. The Mitsubishi interests are also reported to be working on plans for the construction of a power plant in Chosen which, when completed, will be able to generate 200,000 kilowatts.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Heaquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metropolitan Section. Power Division meeting in Room 501, Engineering Societies Building, March 22 at 8 p.m. Subject: "Some Notes on the Performance of Boiler Furnaces," A. T. Brown.

A.S.M.E., Philadelphia Section. Symposium on maintenance in the Society Rooms, March 22 at 8 p.m. Subjects: "Railroad Maintenance," Eliot Sumner; "Public Utility Maintenance," William Oberhuber; "Industrial Plant Maintenance," W. C. Giles.

A.S.M.E., Providence Section. Meeting in the Society Rooms, Apr. 5 at 8 p.m. Subject: "Pure Air," Ely C. Hutchinson.

N.A.P.E., Philadelphia Locals. All-day meeting in conjunction with other engineering organizations, to be known as "Power Engineers' Day," at the Penn Athletic Club, Apr. 2. Technical sessions and entertainment.

Virginia Electric Operating Dept. Sets Safety Record

THE PRODUCTION DEPARTMENT of the Virginia Electric & Power Company has just been awarded the first prize of a silver cup in the 1931 inter-plant safety contest conducted by the Richmond Safety Council, in which contest the company has set up a national record for man-hours operated without a single lost-time accident. Since Jan. 11, 1930, the department, which serves Richmond, Fredericksburg, Petersburg, Hopewell and Williamsburg, had gone 779 days, up to March 1, 1932, and operated continuously 1,061,571 man-hours without a single lost-time accident.

In addition to winning the first prize in the Richmond safety contest, the company is listed on the honor roll of the National Safety Council along with other organizations that have records in excess of 400,000 man-hours, or 200 working days, without a single lost-time accident.

Commenting on this record, J. A. Reich, superintendent of power stations and substations, said:

"This department employes approximately 160 men and operates and maintains one steam power station, three hydro stations, and fifteen substations. During the safety record period six annual inspections on large steam turbine-generators have been made, three substations have been constructed and many of the fifteen have been revamped to make them more modern and efficient. The hydro stations have required also a large amount of maintenance work. In addition, all sixteen boilers, in the past two years, have been completely overhauled, and much hazardous work has been done on live distribution circuits.

William T. Walker Dies

WILLIAM T. WALKER, construction superintendent of the Northern States Power Company, died suddenly on Feb. 25 at Grand Forks, N. D., where he was inspecting improvements under way on the company's plant. He was a nationally prominent figure in the development of electrical service in the Northwest. Mr. Walker was born in Lawrence, Kan., on June 28, 1874, and graduated from the University of Kansas in 1897. He became associated with the Byllesby organization in March, 1910 and the following month he was assigned to construction work on the Rapidan hydro-electric plant and took up his residence in Minneapolis. During the 22 years that followed he acted as construction superintendent for a number of projects, the more prominent of which were Riverside steam station, High Bridge steam station, Granite Falls steam station, Coon Rapids hydro plant, Chippewa Falls hydro plant and other construction projects of Northern States Power Company.

Personals

NORMAN A. HILL, former president of the Engineers Club of Baltimore, Md., has been appointed acting Smoke Commissioner by the Mayor of the City. It is expected that when the City Council votes funds, the Deputy Smoke Commissioner and a number of smoke inspectors will be placed on the payroll to carry out the provisions of the recently enacted smoke ordinance of that city.

JAMES D. CUNNINGHAM, president of the Republic Flow Meter Company, Chicago, Ill., has accepted the chairmanship of the development committee which will work on the expansion program of the Armour Institute of Technology. Based on a survey of engineering and educational requirements of the Chicago industrial area, the development program will include the establishment of a technical institute and an industrial research institute.

ALTEN S. MILLER, vice-president of the Bartlett Hayward Company, New York City, has been re-elected chairman of the board of the Engineering Societies Library for 1932. PROF. WALTER I. SLICHTER, of Columbia University, was named vice-chairman, and Harrison W. Craver, secretary.

OSWALD RYAN, of Anderson, Ind., has been selected by the Federal Power Commission to be its chief counsel. He has had wide experience in utility, economic and social investigations.

H. R. PECKHAM, for the past eleven years assistant general superintendent of the San Diego Consolidated Gas & Electric Company, has been made general superintendent.

Obituary

JOHN T. CLANCY, assistant manager of oil and gas engine sales for the Worthington Pump & Machinery Corporation, Harrison, N. J., died suddenly Wednesday evening, March 9, while addressing the student meeting of the Metropolitan Section of the A.S.M.E. Mr. Clancy was born in New Brunswick, N. J. He attended Bowdoin College and Catholic University, where he received the degree of A.B. and LL.B. in 1913. On leaving college he taught mathematics and chemistry at the Army and Navy School in Washington, D. C. In 1917 he joined the Army, serving as Captain until discharged in 1919, when he entered the employ of the Worthington company. In 1923 he was made assistant manager of oil and gas engine sales.

JOHN A. WICKERT, past national president of the National Association of Power Engineers, died on Feb. 28 at his home in Milwaukee, Wis.

How's Business?

PSYCHOLOGICAL convalescence from the panic stage of depression continues steadily. The narrow fluctuations and slight uptrend of stock prices and the strong, continuous rise in bonds since early January are encouraging surface symptoms. Steady decline in bank suspensions, unseasonal lessening of outstanding currency, and slight increases in member bank deposits and reserve balances are of more basic significance. Expectations of persistent Federal Reserve pressure continue, but signs of any very vigorous seasonal expansion of member bank credit needed to replace depleted purchasing power, improved employment, increased consumption and stimulate business activity are still lacking. In consequence commodity prices show no sustained strength and most industrial and trade indicators at the outset of March are at best stagnant and barely holding their bottom levels.—*The Business Week*, March 16.

Business Notes

AIR PREHEATER CORPORATION, Wellsvills, N. Y., announces the appointment of the Fuel Economy Engineering Company, St. Paul, Minn., as its representative in that territory.

PHOENIX IRON & BOILER WORKS and BYER-ANDERSON COMPANY, both of Sacramento, Calif., have consolidated and are now operating under the name of Byer-Anderson-Stocker Company at the plant formerly occupied by the Byer-Anderson Company.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, has appointed B. F. McIntyre, formerly with the Industrial Controller Company, to its Chicago office, and Fred Archer, who was president of Fred Archer, Inc., to its Philadelphia office.

GEARS & FORGINGS, INC., Cleveland, Ohio, announces the appointment as sales agent of the Frick-Reid Supply Corporation, 117 Sandusky St., N.S., Pittsburgh, Pa.

C. C. MOORE & COMPANY, engineers, and the BABCOCK & WILCOX COMPANY, San Francisco, Calif., announce the removal of their offices last month to their own building at 450 Mission Street, corner of First Street.

CENTRIFIX CORPORATION, Cleveland, Ohio, announces the appointment of the following new sales representatives: J. A. Dougherty, who will cover the northern Ohio territory from the home office in Cleveland; Charles M. Swart, who will cover the state of North Carolina from Greensboro; Green & Boulding, Ltd., 162a Dalston Lane, London, for Great Britain and Ireland; and W. A. Ramsay, Ltd., Fort & Queen Sts., Honolulu, for Hawaii.

LORAIN COAL & DOCK COMPANY, Columbus, Ohio, announces the following changes in personnel by the election of S. B. Johnson vice-chairman, succeeding himself as vice-president in charge of operations; A. C. Saunders, Jr., vice-president; Roy C. Gilbert vice-president in charge of sales; and Charles G. Johnson general superintendent, succeeding James W. Johnson, general manager, resigned, and George W. Wyss, assistant general manager, deceased.

Trade Catalogs

VALVES—Three fully illustrated bulletins, containing descriptive matter and specifications, have just been issued by the Chapman Valve Manufacturing Company, Indian Orchard, Mass., on "Tilting Disc Valves"; "Forged Steel Globe, Angle and Check Valves"; and "Lubricated Plug Cocks."

PROCESS EQUIPMENT—Bulletin No. 71 describes the service the Edge Moor Iron Company, Edge Moor, Del., offers for the fabrication of special equipment involving problems of heat, corrosion and contamination resistance. The booklet illustrates the company's shop facilities for handling soot equipment, as well as examples of completed projects designed for unusual services.

TURBINE-GENERATORS, MOTORS—Two new bulletins have been issued by the Elliott Company, Jeannette, Pa. Bulletin H-7 covers the design and construction of steam turbine-generators, with blueprints, detail and installation pictures. There is a section on turbine efficiency that includes a total heat-entropy diagrams and chart of overall efficiencies. Bulletin J-4 describes commutating-pole direct-current motors and generators, with particular comment on armature windings, commutator construction, etc.

WELDED PIPE—The progressive processes of making weld line pipe and casing are attractively presented in a new catalog of the Republic Steel Corporation, Youngstown, Ohio. Included in the publication are tables of dimensions, mill-test standards, safe working pressures, factors of safety, threads and couplings. Requests for copies should be made on business letterheads.

COOLING TOWERS—Construction features of forced-draft spray cooling towers are described in a new bulletin released by the Marley Company, 1737 Walnut St., Kansas City, Mo. Numerous detail and installation pictures are included.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles — Bureau of Power & Water, completing plans for construction of a 150 x 200 ft. power plant, suitable for two units. Designed to permit three additional units. Estimated cost to exceed $150,000. H. A. Van Norman, Chief Engr. and Manager.

Colo., Grand Valley—Bureau of Reclamation, Denver, awarded contract for turbines, turbine governors and governor pumps to Pelton Water Wheel Co., 2929 19th St., San Francisco, Calif.; generators and exciters, to Electric Machinery Manufacturing Co., 1331 N. E. Tyler St., Minneapolis, Minn.; switchboard to Standard Mechanical Equipment Co., 2010 Richardson St., Dallas, Tex., in connection with Grand Valley power plant here. Total cost $69,936.

Conn., Danbury—Clear Ice Co., F. Hain, 52 Meadow St., South Norwalk, having plans prepared for construction of a 1 story, 45 x 150 ft. ice manufacturing plant. Estimated cost $50,000. Harry Koener, 83 Fairfield Ave., Bridgeport, is architect.

Conn., Middletown—Norbert King, 20 Boston Road, awarded contract for construction of a 1 story, 40 x 90 ft. ice manufacturing plant on Boston Road to O'Brien Bros., River Road. Estimated cost $40,000.

Conn., New Britain—Spring Brook Ice Service. H. E. Doerr, 17 Spring St., plans construction of an ice manufacturing plant on Spring St. Estimated cost $45,000. Private plans.

Fla., Pensacola—Bureau of Yards & Docks, Navy Department, Washington, D. C., plans dismantling and removing existing cold storage rooms and ice making equipment, also relocation of certain existing equipment, etc., at Navy Yard here.

Fla., St. Petersburg—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., awarded contract for sewage treatment control house to J. B. McCrary Co., 584 Bankhead Ave., Atlanta, Ga., refrigeration and ice making plant to Pennsylvania Engineering Co., 1119 North Howard St., Philadelphia, in connection with group of buildings at Veterans' Administration home here.

Idaho, Twin Falls—Murtaugh Irrigation District, has made application to Reclamation Commission, Washington, for permit to construct power plant at Augur Falls on Snake River. Estimated cost $2,500,000. H. T. Henderson, Twin Falls, is chief engineer.

Ill., Morris—City having plans prepared for waterworks improvements including pump house, pumping equipment, etc. Estimated cost $35,000. Contract for test well awarded to Lowe N. Central Co., 1421 South Circle Ave., Forest Park. Maturity about May 1.

Ill., Wilmette—Village will receive bids until March 29 for construction of a waterworks filter plant, 6,000,000 gal. daily capacity, including low and high lift pumping station, etc. Pearse, Greeley & Hansen, 6 North Michigan Ave., Chicago, are engineers.

Ia., Marengo—City plans an election March 28 to vote $125,000 bonds for construction of municipal power and light plant including equipment. G. Lindsay, city clerk.

Ia., Sumner—City plans an election March 24 to vote bonds for construction of a complete light and power plant. H. L. Cory, 1034 Redick Tower, Omaha, Neb., is engineer.

Ia., Villisca—City plans an election March 28 to vote $150,000 bonds for construction of a power and light plant. Former election contested as illegal. Iowa Equipment Co. of Des Moines enjoined from starting work on new plant. New bond issue to decide.

Ky., Paris—City having plans prepared for construction of a municipal light plant. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Mass., Hopedale—Hopedale Coal & Ice Co., W. H. Barney, plans construction of an ice manufacturing plant. Estimated cost $50,000. Private plans.

Mass., Leominster—Leominster Ice Co., 229 Pleasant St., will soon award contract for construction of a 1 story, 50 x 75 ft. ice manufacturing plant. Estimated cost $40,000. Private plans.

Mass., North Leominster—Harris Ice Co., Day St., awarded contract for construction of a 1 story, 60 x 70 ft. ice manufacturing plant on Main St. to Proffit & White, 13 Oliver St., Fitchburg. Equipment awarded to Frick Co., 185 Lincoln St., Boston. Estimated total cost $50,000.

Mass., Salem—South Essex Sewage Board, Fort Ave., plans to rebuild pumping station at Salem Willows. Estimated cost $50,000. Private plans.

Minn., Duluth—Duluth Steam Corp., J. J. Dwyer, Gen. Mgr., awarded contract for steam generating and mechanical equipment including four large boilers for central steam power plant, to Edge Moor Iron Co., Edge Moor, Del. Estimated cost $500,000.

Mo., St. Joseph — Dugdale Packing & Cold Storage Co., R. F. D. No. 5, awarded contract for construction of 1 story, 50 x 66 ft. packing and cold storage plant at South 11th Street Road to North St. Joseph Real Estate Co., 119 South 6th St. Estimated cost $40,000.

Mo., Washington—City plans construction of a municipal power plant and distribution system. Estimated cost $150,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, are engineers.

N. J., Millville—Cumberland County Gas Co., plans completed for a 2 story addition to gas plant and office on Second St. Estimated cost $40,000. Work will be done by separate contracts under the supervision of Ford, Bacon & Davis, 39 Broadway, New York, N. Y., engineers. Maturity indefinite.

N. J., Rahway — Common Council, having sketches made for construction of a sewage pumping plant near Rahway city line. Estimated cost $60,000. Alex Potter, 50 Church St., New York, is consulting engineer.

Pa., Media—Philadelphia Electric Corp., 1000 Chestnut St., Philadelphia, plans 110 x 150 ft. sub-station or power plant addition at Jefferson and Randor Sts. here. Site acquired. Maturity indefinite.

Tex., Muenster — City, c/o B. H. Hellman, Mayor, will receive bids until March 16 for waterworks improvements including pumping unit, distribution system, etc. Ward & Montgomery, Wichita Falls, are engineers.

Tex., Pelly — C. R. Haden and J. Shaw, Houston, and Pelly, plan erection of a light and power plant to include complete lighting system, etc. Estimated cost $30,000. Franchise granted, site selected.

Va., Richmond—Virginia Electric & Power Co., plans to expend large sums during year for extensions and improvements including sub-stations, etc.

B. C., Grand Forks—City awarded contract for construction of a municipal power plant to Yuill & Knight, 626 West Pender St., Vancouver. $45,000. Equipment including turbines and generators, 230 hp. each awarded to Canadian Westinghouse Co., Marine Bldg., Vancouver.

Man., Churchill—J. L. R. Sutcliffe, Chief Clerk, Department of Natural Resources, Parliament Buildings, Winnipeg, plans construction of a steam heating plant here when townsite is opened for settlement.

Man., St. Vital—City, Reeve H. G. Wyatt, plans construction of a direct water main from City of Winnipeg aqueduct, as its connection to city of St. Boniface's system does not give sufficient pressure. Project includes erection of a pumping station. Estimated cost $63,000. C. G. Muller, St. Vital, is engineer.

Equipment Wanted

Boiler — Washington, D. C. — Treasury Department, Office of J. A. Wetmore, Supervising Architect, will receive bids until March 16 (extended date) for boiler installation including boilers, soot blowers, settings, casings, stokers, forced and induced draft fans, etc., in central heating plant for public building and grounds.

Boilers, Burners, Pumps, etc. — Sunnyvale, Calif.—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until April 6 for portable firebox boilers, gas burners, smoke breeching, reciprocating boiler, feed pumps, motor driven vertical shaft hot well and drainage pumps, water softening equipment, deaerating feed water heater, etc., for Navy Yard here.

Coal Burning Equipment—Pittsburgh, Pa.—City, C. M. Reppert, Engr., considering purchase of automatic coal burning equipment for heating boilers at East End Asphalt plant.

Electrical Equipment—Boston, Mass.—Transit Department, 1 Beacon St., will receive bids until March 30 for electrical equipment for Traffic Tunnel including motor generators, transformers, induction voltage regulators, storage batteries, control and meter boards, two 15 kv., three 2,500 kv. and four 480 kv. switch gears, lighting and service panels, motor controllers, etc.

Engines—Marshall, Minn.—City Council, A. G. Bumford, Clk., will soon receive bids for Diesel engines for municipal light and power plant.

Generator Set—St. Paul, Minn.—State Building Commission, Henry Rines, Secy., State Capitol, will soon receive bids for a new motor generator set for State Capitol power plant.

Pump—London, Ont.—City plans to purchase new outlet sewer storm clarifier pump in connection with proposed addition to sewage disposal plant.

Pumping Equipment—Verona, Wis.—Village will receive bids until March 18 for pumping equipment, etc., for proposed waterworks system. Estimated cost $35,000.

Pumps, Motor, etc. — Summerland, B. C. — Dominion Government, c/o W. M. Fleming, Acting Supt. of Stations, Ottawa, plans to purchase pumps, motors, etc., in connection with proposed waterworks improvements at Dominion experimental station here. Estimated cost $25,000.

Refrigerating Equipment—Great Lakes, Ill.—Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to purchase refrigerator and refrigerating equipment at Naval Station here. No date set for bids.

Industrial Projects

Conn., Thomaston—Otto Vogt, North Main St., plans completed for a 1 story, 55 x 120 ft. factory including boiler room. Estimated cost $40,000. Private plans.

Ill., Joliet—J. F. Bittermann Steel Products Co., 1401 East Cass St., plans construction of a 100 x 200 ft. factory on Collins St. Estimated cost $75,000. Architect and engineer not selected.

Ind., New Albany—M. Fine & Sons, awarded contract for construction of a 2 story, 100 x 160 ft. factory at Main and 14th Sts., to United Construction Co., 301 Breslin Bldg., Louisville, Ky. Estimated cost $42,000.

Mass., Malden—Malden Products Co., c/o A. E. Mace Co. Inc., 93 Heath St., Roxbury, Engrs., plans to remodel factory at Edgeworth Section. Estimated cost $50,000.

N. Y., Long Island City — Anchor Cap & Closure Corp., 22 Queens St., acquired a site at Dutch Kills to Purvis St., and plans addition to plant, 22,000 sq.ft. Maturity indefinite. No immediate development.

Wis., Milwaukee—Filer & Stowell, 219 Becher St., awarded contract for construction of a 1 story, 63 x 168 ft. factory for the manufacture of saw mill machinery, engines, castings, etc., to Klug & Smith, 111 East Wisconsin St.

Ont., Toronto—McQuay-Norris Manufacturing Co., W. K. Norris, Pres., 2320 Cooper St., St. Louis, Mo., receiving bids for a 1 story, 80 x 140 ft. piston ring plant in York township here. Estimated cost $100,000.